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A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. VIII. NEW YORK, APRIL, 1903. No. 2.

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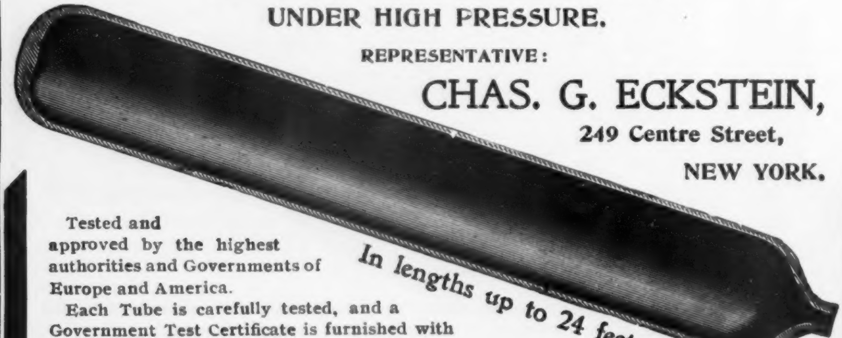

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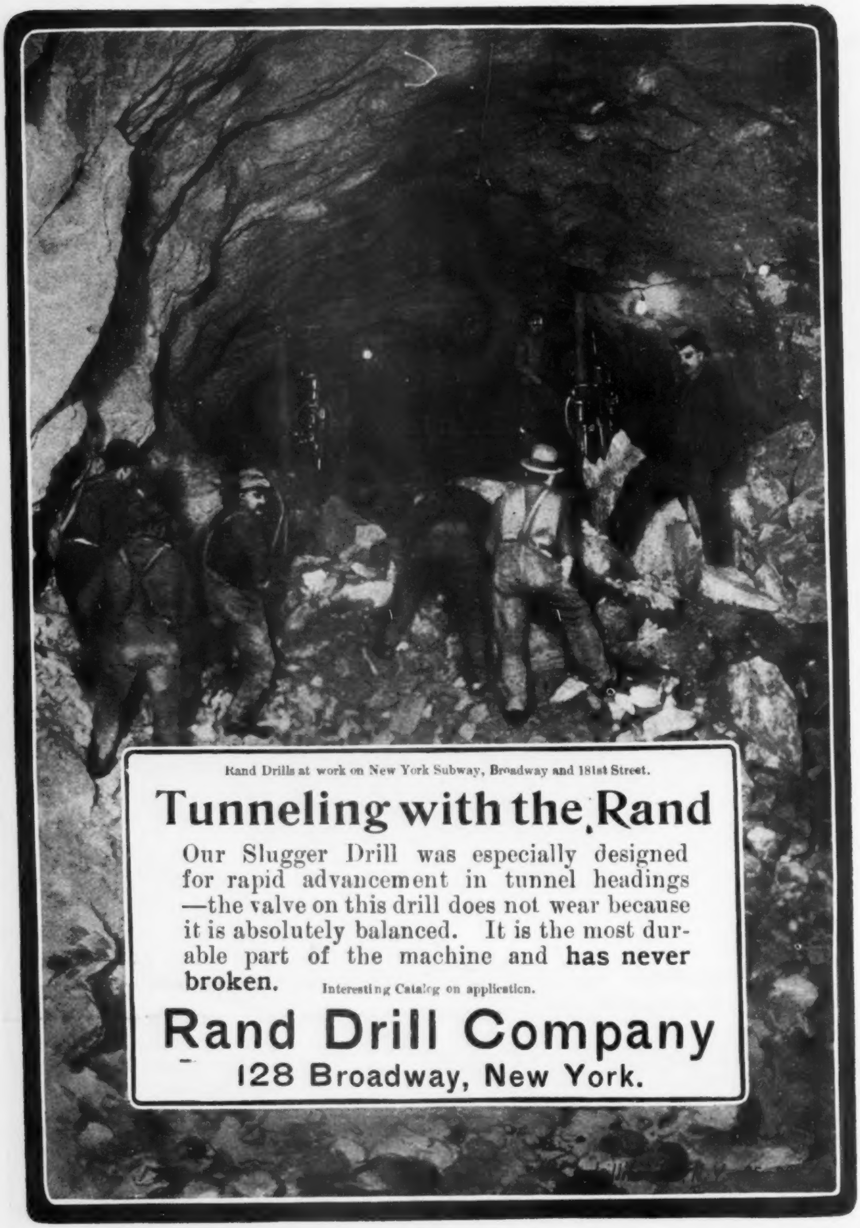
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Oil and Dust from Rock Drill Use in Mines.

It is an encouraging sign of the times that the question of the health of the miners should receive such serious consideration as is recently being given it in connection with work in mines. In South Africa a commission has been appointed and it is alleged that laws are to be passed specifying certain regulations by which the lives of the miners will be prolonged. Opinions differ as to what causes the trouble, but no one doubts the fact that the lives of miners have been shortened by some of the conditions that exist in mines, and particularly in the African mines. It is well known that ventilation is an important auxiliary to men working in mines. Bad ventilation in mines is just as hurtful as bad ventilation anywhere else, and unless the miners have good air to breathe they are liable to be affected by diseases, especially so as the damp atmosphere in the mine and the changing degrees of temperature cannot be considered as favorable conditions. Some think that oil either from the air compressor or from the rock drill is responsible for the miners diseases, and cases have been cited where asphyxiation and even death have resulted from the discharge of "bad air" into the mine through the pipe leading from the engine room. We have a record of perhaps the most serious case of this kind, one which occurred several years ago in a western mining field and which resulted in the death of more than a dozen men, the direct cause being a fire in the engine room, and as the air compressor throttle had not been closed the machine continued to work while the building was burning all around it; hence the products of combustion were sucked into the compressor and forced into the mine, the miners being ignorant of the existence of a fire on the surface and having no means by which to discover the trouble until it was too late to prevent serious consequences. Here is an accident which cannot be compared with normal conditions and yet it has a bearing on the case, because it points to unforeseen possibilities and also to the importance of discharging only pure air through the line pipe into the mine. Pure air is not always compressed by air compressors. This is due sometimes to defects in design and at other times to negligence. A properly designed air compressor when used to pump air into a mine should have compound air cylinders, with intercoolers and aftercoolers. To compress air up to pressures from 75 to 100 pounds in one stage by a single blow, as it were, is to heat it beyond reasonable temperatures and to burn the air to such an extent as to produce unhealthy conditions. Stage compression means a gradual piling up of pressure with a gradual increase of temperature and no smell from

burnt oil or other particles, which are often taken in with the air and heated to excessive temperatures during compression. By stage compression not only are lower maximum temperatures produced, but the air is brought down to atmospheric temperatures when passing through the intercoolers and aftercoolers, and in this way less power is consumed in compressing the same volume of air to the same pressure, and such things as oil, smoke, water and dust are collected by the cooling devices and blown off just as sediment may be blown off from a boiler.

It is said that oil when discharged from the exhaust of rock drills is hurtful to the miners and that it interferes with the amalgamation process. As to its being hurtful to the miners, we can scarcely agree to the possibility of this, as when the oil is discharged from the exhaust it is at such low temperatures as to be condensed into a liquid which drops to the floor or is blown against the walls of the mine. In other words, it is not in the condition of a vapor or gas. As to its interfering with the amalgamation process, the late Mr. Collins, of the Smuggler Union Mine, at Telluride, Colo., who was an acknowledged expert in all that pertains to mines, made some exhaustive experiments to determine the effect of oil upon the amalgamation plates, the results being uniform in each case and showing no effect whatever. Oil floats on the surface of water, while the particles of gold sink to the bottom. Oil being lighter than water, it is not at all likely that it will carry particles of gold with it. But whether oil, when used in rock drills, is hurtful or not, it is plain that too much oil is used and too little attention is given to the wastefulness of oil. When a rock drill becomes worn, its efficiency is much improved by frequent doses of oil. This is especially true of rock drills that have independent valves; that is, valves that are not moved by direct mechanical connection with the piston. The oil fills up loose spaces and with the aid of lubrication the machine works more like a new one. Of course, the proper plan to pursue when a rock drill is worn is to take it out of the mine and repair it, because a loose piston and a loose valve waste air, and in most mines they are wasteful also in oil. However this may be, a runner usually keeps the machine at work until it breaks down or will not work any longer, so that it becomes important to recognize this situation and endeavor to save in some other direction. It is bad enough to waste air, but when so much oil is thrown away, this wastefulness becomes important and even serious. A little soap and water will save money and accomplish the same results when fed into a worn rock drill, and nobody will claim that soap and water interferes in any way with either the health of the men or with the amalgamation process. It is cheaper than oil, it is a fair lubricant and in the cold passages of the rock drill it becomes thickened and serves an excellent purpose in filling up loose spaces. It cannot injure the machine, provided it is not allowed to remain in the machine when it is idle, as in such a case as this it might produce rust. Just before shutting down the rock drill oil should be run through, and in this way the soap and water will be neutralized by the oil and the machine made free from rust.

The real cause of the so-called miner's consumption is, in our judgment, due to the fine particles of dust that permeate the atmosphere and become impregnated in the lungs of the miners. This dust is only excessive in dry hole work or in raises where it is difficult to introduce water into the hole in the process of drilling, but it is quite possible to prevent this entirely by the injection of water through the drill steel, or by forcing it through a tube which is placed alongside

of the steel and which is connected to a common bicycle foot pump. The trouble is that too little attention is given to matters of this kind, because dry hole work in mines is not general and the miners do not care to change to any special appliances when engaged in this work. It is quite likely, however, that agitation of the subject will result in the introduction of practical appliances by the use of which excessive dust in the mine may be absolutely prevented.

Sand Blast Cleaning of Structural Steel.*

It is intended to set forth, in this paper, some of the results which have been attained in the use of the sand-blast in cleaning steel plates and structural steel. Some data as to the cost and other elements which enter into its application will be presented, in the hope that possibly something may be added to the facility of making approximately accurate estimates of the cost of any sand-blast cleaning which may be in contemplation hereafter. Some of the work heretofore done has been referred to in a paper, published in *Engineering News* of April 24th, 1902; and in it the cost of cleaning 12,600 sq. ft. of the Front Street Viaduct over the Little Miami Railroad, in Columbus, Ohio, was stated. In presenting the experience gained in the continuance of the work during the season of 1902, giving results in cleaning a total area of 135,500 sq. ft. on viaducts in that city, which have been repainted since the early part of November, 1901, it is hoped to add a record of at least some value.

If it leads to a thorough discussion, and if members of the society add to the record, the most important part of the purpose in presenting this paper will have been realized.

During the past few years some attention has been given to attempts to secure thorough cleaning of structural steel before the application of the preservative coating; but, unfortunately, we are still far from the realization of the kind of work which should be required. Much has been written relative to the kind of paint which will best preserve the steel and iron used so extensively in a great variety of structures. In the discussion, which has been going on for many years, many have argued very strenuously against, and many just as earnestly in favor of, perhaps every kind of paint now used largely as preservatives of ferric structures from the ravages of rust and corrosion. But, in the discussion, they have often lost sight of the very important matter of cleaning the steel properly. On account of the great deterioration of such structures, in the past, whether by reason of exposure to the weather on land or at sea, or to the action of acids, or the gases and moisture of coal combustion, in combination with the oxygen of the atmosphere, this is a question of vital interest to all engineers and others concerned in their erection or maintenance. Nevertheless, comparatively little has been done thus far toward securing such cleaning as will insure a much longer life for, as well as economy in the maintenance of, such structures. The dawn of a better day seems to have appeared, in the application of better methods, in some instances, on new work, and, in more cases, on the old; and it is to be hoped that the full light of that day may soon be seen, in the results on new work in the shop—as a provision for the future—and on old structures—to undo, as far as possible, the neglect of the past.

It has often been observed that mill marks made with paint of a very inferior quality have afforded good protection to steel, while other portions, covered with a much better paint, have been much affected by rust, the latter even extending under paint which, for the most part, has still retained its continuity and elastic qualities. The explanation is found in the facts that the mill marks were made when the metal was clean, and that the paint applied subsequently was spread upon the mill scale, rust and grease which had accumulated upon it before the shop work was finished. However excellent may be its qualities, it is absurd to expect any paint to preserve steel to which it is applied, unless the mill scale, rust, dirt and grease have been first removed. This observation applies with equal, or, it may be said, with even greater force, to the repainting of old structures which have been neglected, and upon which rust and corrosion have proceeded so far that it

*Paper presented before American Society of Civil Engineers by Mr. Geo. W. Lilly, Asso. M. Am Soc. C. E., and published in the society's proceedings for February, 1903.

is impossible to secure good preservation by ordinary methods of cleaning. Having this knowledge in mind, it is proper to determine, from the conditions met in any case, what is necessary to be done in order to insure that the preservative coating shall be applied only after the surface of the metal is clean and in proper condition to receive it. To accomplish this, there is no doubt that much of the new as well as old steel will be required to be cleaned by means of the sand-blast, as the only practicable and effective method. Much of the steel, after leaving the mills, is stored out-of-doors and exposed to the weather for a considerable length of time before the shop work is done. Thus its rusting often progresses to such an extent that the ordinary process of cleaning with wire brushes, even if that be attempted, is not sufficient to permit the paint to come into immediate contact with and become firmly adherent to the metal. The quality of the paint used, on new structures as well as old, is an important matter; but that cannot be discussed in this paper.

The effectiveness of the sand-blast process depends upon the ability of sand, used as a projectile, to break up, wear away and remove the substances against which it is directed, when actuated by a current of compressed air. All the machines, often called mixers, for the application of this process, are intended to secure the introduction of the proper proportion of sand into a current of compressed air, passing through a pipe. This current of compressed air, bearing with it the sand thus introduced, is then directed into and through rubber hose, preferably 2¼ or 2½ ins. in diameter, and a steel or iron nozzle of suitable size, and against the surface to be cleaned. Sometimes the air-blast alone may be used to remove dust and soot. Such an appliance was first invented and patented by General Benjamin C. Tilghman, the patent being issued on October 18th, 1870. This appliance, as improved by Mathewson, is still on the market. In this apparatus, a slotted slide, operated by a lever, regulates the quantity of sand introduced into the current of air. This is shown by the sectional drawing, Fig. 1.

In the Paxson-Warren machine, Fig. 2, the feed of the sand is regulated by a revolving piece, or valve, which covers the opening in the bottom of the hopper to the extent desired to let the proper quantity of sand fall through it and into the air pipe.

In the machine patented by J. M. Newhouse, of Columbus, Ohio, shown in Fig. 3, the sand passes from the hopper at the bottom through an annular opening around the end of a nozzle-shaped steel piece, which decreases in its outer circumference toward the end; and by raising or lowering it, this annular opening may be increased or diminished in size. The distinguishing feature of this appliance is the use of this nozzle as a

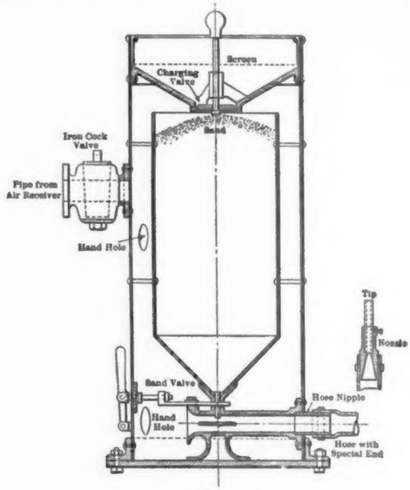


FIG. 1.

MATHEWSON'S SAND-BLAST.

siphon, with its perforations as shown. The small holes permit part of the air which flows through the small pipe and the siphon to escape outwardly through the surrounding sand, thus stirring it up and preventing it from clogging at the opening. A similar siphon, without the perforations, is placed in the air pipe.

Possibly there are other machines, but the writer is not familiar with them. Any of the sand-mixers may be made with two chambers, with valves arranged so as to lock the sand through the upper one into the lower one while the sand-blast is in operation.

The greatest merit of the sand-blast is that it removes from the surface of the

metal every trace of dirt, scale, rust and grease, and the bright, metallic surface is everywhere exposed and perfectly clean. This is an ideal condition to secure the strong adhesion of the paint, so that, so far as it is possible, it will protect the metal. The thoroughness of the cleaning effected by the sand-blast is noted especially upon the metal surfaces which have been pitted by rust and corrosion to a considerable degree. The pits are thus cleaned as thoroughly as other places.

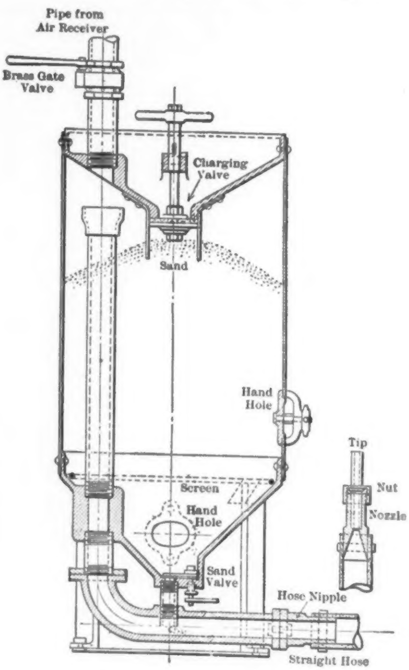
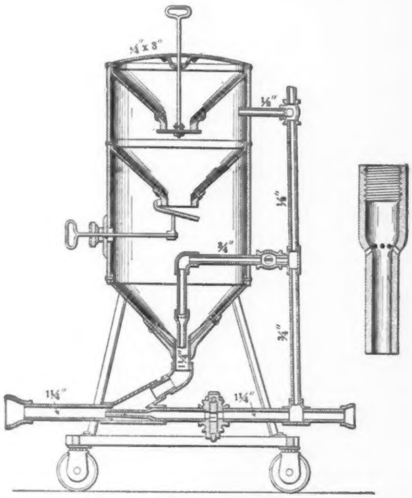


FIG. 2.

PAXSON-WARREN'S SAND-BLAST.

It also reaches and cleans effectually every portion, in re-entrant angles and on the edges of the different sections of a beam, girder or post, on and around rivet heads, and in many other places either entirely inaccessible to the wire-brush or steel-scraper, or on which they are used with great difficulty and little effect.

Such places cannot be cleaned thoroughly by hand, even with the most diligent effort. Even plane surfaces of considerable area, on old structures requiring re-painting, especially where covered largely with scales and rust, can not be thus cleaned so as to remove all the dirt, rust, scale and disintegrating paint. There will still remain sufficient rust and scale to separate slightly the paint from the metal, so that there is not the intermate contact and firm adhesion necessary to prevent the rusting process. The continuity of the coat of paint will soon be broken at places, and moisture and gases in the atmosphere coming in contact with the metal, rust will be formed even under places where the paint remains intact.



THE NEWHOUSE SAND-BLAST.
FIG. 3.

Paint applied to such surfaces can often be stripped off like the peel of an orange, and still remains tough and elastic. Good paint it may be, but it has never taken a good hold on the steel. On the other hand, the writer has seen a piece of old steel, which was cleaned and painted with red lead in 1899, on which the paint will not peel off at all, but may be cut away, still leaving the under portion tightly adhering to the steel.

The sand-blast has been found serviceable and economical for other purposes than the cleaning of steel plates and

structural steel.' It is used in cleaning iron and brass castings, either by the direct application of the blast, or by introducing the sand-blast through the hollow trunnion of the tumbling barrel in which the castings are placed. The inner, as well as the outer, surfaces of castings are thus cleaned, and the sharp lines of the edges preserved, while the cleaning effected by the tunbling barrel without the sand-blast tends to round off the corners. Its use to clean street railway rails and fish-plates, for cast and electric welding, is familiar to all. It is also quite effective in cleaning cut-stone work. One of the ice-manufacturing companies of Columbus, Ohio, has recently purchased a sand-blast machine for use in removing from its condenser pipes the lime scale formed from the hard water used.

The Columbus Railway Company has made use of it in cleaning about 18 ins. in length of a large number of its iron trolley poles, just above and below the surface of the ground. At this point the poles had rusted to such an extent as to weaken them materially, and it would soon have been necessary to replace many of them. After cleaning in this way, a coat of paint was immediately applied, and soon afterward each pole was encased in a cylinder of cement mortar tamped into removable form.

The sand-blast has also been used at the shops of the Pan Handle Railway, and in other railroad shops, in cleansing the tenders of locomotives before repainting. A great saving of expense is thus realized and superior work is obtained. It would be attempting too much to take up the methods and relative costs in these various lines of sand-blast work.

It seems that, beyond a few scattered experiments, only during the past six or seven years may be found any published record of the application of this process to the cleaning of structural steel. And, even in these recent years, no very great amount of such cleaning has been done. Most of the trials heretofore made have been upon a somewhat experimental basis, and yet something may be learned from them. It is still rather problematical as to how cheaply the mill scale, rust and grease could be cleaned from new steel plates and structural steel, if an efficient permanent plant were provided for the purpose. Some new plates for the bilge keels of the Massachusetts were cleaned at the United States Navy Yard, Brooklyn, in April, 1897. With one nozzle, 3,155 sq. ft. of surface were cleaned in 11 hours. This is at the rate of 286.8 sq. ft. per hour. The cost of the work was 0.56 cent per square foot. Upon this basis the writer estimated that the sand-blast cleaning of new steel plates, I-beams and other sections, would cost from 50 cents per ton, for very heavy sections, to $1.75 per ton, for light sections. This would not be a very large additional expenditure upon steel structures, considering the longer life which it would, no doubt, insure for the steel thus treated. The rapid deterioration and wasting away which has been observed on bridges and other structures may well cause builders of steel-framed buildings to consider the advisability of cleaning the steel in this way, before painting it and hiding it from inspection in the walls. The safety as well as the durability of such buildings may depend upon better provision against the rusting out of these steel frames. Who knows?

The steel for the anchorages of the cables of the New East River Bridge were cleaned by the sand-blast, under the direction of L. L. Buck, M. Am. Soc. C. E., Chief Engineer. This was done for the special reason that it would be "buried in the masonry, and would be totally inaccessible for all time." This process was also used on some of the steel in the Boston subways, Howard A. Carson, M. Am. Soc. C. E., Chief Engineer. The writer has no figures as to the cost in these cases.

Much of the expense of repainting in the future would be saved if greater care were taken in securing thorough cleaning at the shops before applying the first coat of paint to new work. If this is to be accomplished, it will in many cases be found necessary to use the sand-blast; but this will not be done until the purchaser is willing to pay for it; and he must be convinced of its necessity and ultimate economy before he will be willing to do so. When there is a demand for it, the shops will be equipped with the necessary machinery, and will be able to do it more cheaply. At present, one shop has to bid against the other, and, none of tnem being required to make bids with such cleaning as a part of the specifications, the bids are such that the shops probably cannot afford to clean the steel

properly, in some instances at least. They are averse to this process because of the expense of fitting up for it, the delay in getting the work out, and the cost of handling. Therefore the purchaser must be the prime mover in securing such work.

In the cleaning of old structures for repainting, this process has been more extensively applied, and, therefore, there are better data relative to such work than as to the cost of cleaning new steel at the shops. The necessity of its use to preserve old structures requiring repainting is more apparent than the more remote future saving of the expense of its application for repainting, by a much smaller outlay to secure thorough cleaning before erection.

During the latter part of March and the first two days of April, 1897, the bottom of the United States steamship Atlanta was cleaned at the United States Navy Yard, Brooklyn, by means of the sand-blast, the plant used being furnished by Ward & Nash, of 26 Whitehall street, New York City, who had the contract for the work. Its cost was 4.24 cents per square foot; but the work was done on a more or less experimental basis, and, with the added experience of the past six years, and a more perfect plant, it could probably be done for much less.

The work done on the One Hundred and Fifty-fifth Street Viaduct, in New York City, under the direction of E. P. North, M. Am. Soc. C. E., Consulting Engineer, during the year 1897, is familiar to all.* The cost of this work was reported as averaging about 13 cents per square foot, ranging from 20 cents, at the first, down to a little less than 10 cents, in the latter part of the work of cleaning 50,000 sq. ft. of surface. The pressure of compressed air then used was only about 20 lbs. at the sand-blast apparatus, which is without doubt too low a pressure for the efficient removal of scale such as had accumulated there. It would seem, from recent experience, that a pressure of 35 lbs. would have been much more effective. This is true, because the viaduct was covered to a considerable extent with heavy rust scale and four layers of old paint, and a pressure of 35 lbs. would have made the sand projectiles much more efficient in breaking up and throwing off such scale.

M. E. Evans, Assoc. M. Am. Soc. C. E., who was in immediate charge, estimated that the 600,000 sq. ft. of the painting surface of the viaduct could be cleaned for about 7.5 cents per square foot. It is quite probable that this could be done now at half that estimate, at least on all portions of the viaduct except the members having a very small extent of surface, where much sand and air are wasted in missing the steel along the edges.

The next work of this kind reported upon was the cleaning of the iron lock-gates and a portion of the aqueduct of the Muscle Shoals Canal, during the years 1898 and 1899, under the engineers of the United States War Department. The first report of this, made before its completion, is found in the House Documents for 1898-9.* This covers the work done to June 30th, 1898; and, on page 1926, Major Kingman states that the cost for cleaning was about 2.3 cents per square foot. In the report† of Sydney B. Williamson, M. Am. Soc. C. E., made after the completion of the work in 1899, the cost of cleaning 49,664 sq. ft., and painting it with red lead, is stated to be $0.0588 per square foot. Allowing a reasonable amount for the painting, it is probable that 3 cents per square foot would be very near the cost of the cleaning alone. In this case the plant was erected on a barge, roofed over, and was very well arranged to accomplish the work. The cost of the plant was included in this statement, and the same plant could be used for continuing such work. This cost was about one-third of the whole cost of cleaning and painting.

During the year 1899 the Pittsburg, Cincinnati, Chicago and St. Louis Railway Company used the sand-blast for cleaning the columns and girders supporting its buildings over the railroad tracks, along the east side of the High Street Viaduct, in Columbus, Ohio. The girders support brick arches, and there are no buckle plates. They are subjected to the blast, gases and steam from the large number of locomotives passing to and from the Union Depot, and freight and switch engines passing under them at frequent intervals. This company also cleaned part or all of a bridge at Akron, Ohio. No accurate account was kept of

* *Engineering News*, September 23d, 1897, p. 198; *The Engineering Record*, September 25th, 1897, p. 356; and other engineering periodicals.

* War Department Reports, Engineers, Part 3, p. 1925 *et seq.*

† Engineer's Report, Part 3, p. 2289, House Doc. for 1899 to 1900.

the cost and the area cleaned; but, from the best available information, it is estimated to have been about 3 cents per square foot. J. M. Newhouse, the inventor and patentee of the Newhouse Sandblast, is foreman for this company, and his apparatus was used in doing the work.

The city of Columbus, Ohio, has six viaducts in the vicinity of the Union Station, by which the streets pass over the railroad tracks. All the railroads passing through the city, except one, enter and leave the Union Station under the Fourth Street Viaduct near the east end, and the High Street Viaduct near the west end; and some of them pass under each of the other viaducts, one to the west and three to the southwest from the High Street Viaduct. Besides the freight and passenger trains passing under them, much switching is done under each by the yard engines. Hence, all these viaducts have been attacked seriously by rust and corrosion; and, on the portions most exposed to the blast, steam and gases from the locomotives, nearly all the paint has been destroyed and the metal consumed to a considerable extent. The Fourth Street Viaduct has been injured most, and two years ago it was cleaned by hand and repainted. This viaduct was erected in 1891, and was repainted in June, 1894, in September, 1896, and again, at the time above mentioned, in the fall of 1900. When the last repainting was progressing it was found necessary to replace with new ones, seventeen of the 7-in. I-beams supporting the plank floors of the sidewalks over the tracks most used by freight trains and yard engines. The viaduct was painted under a contract, and considerable care was taken in trying to clean it as thoroughly as possible with steel scrapers, brushes, chisels and hammers. The hammers were often vigorously used to jar the scales loose by blows against the steel, and then scrapers, chisels and wire brushes used to complete the work.

At that time the sand-blast was suggested by the Engineering Department, but was not used. With as thorough work as could be done, many scales, so tighly cemented to the steel that they could not be detached, were loosened, upon the application of the first coat of paint, by the softening effect of the oil acting upon the cementing rust. The paint then applied began to scale in places within six months thereafter, partly due to the inferior quality of the first coat of paint and partly to the rust, soot and scale left upon the steel when repainted. The flange-angles of the floor stringers continued to waste away, and, in the summer of 1902, it was found necessary to replace, by new ones, the two angles of the lower flange on each of ninety floor stringers.

The new angles were surrounded with a covering of Portland cement mortar, 1 to 2 mixture, about ¾ to 1 in. thick. This was rammed under the lower surface of each beam, between it and a plank form, which was left to hold it against the steel until it had set for 48 hours. A wire netting, four meshes to the inch, secured by sheet-iron fasteners placed on the rivets as they were driven, was placed so as to surround the lower flange-angles before the cement mortar was applied. The cement covers the angles and netting completely, and is expected to protect them from rust. After seven months the cement is still intact, and shows no sign of cracking.

In view of the rapid deterioration of the viaducts of the city, and the prospect of having to replace them in a few years unless something were done to arrest it, the city authorities were induced to adopt the sand-blast as a means of cleaning them before repainting. Julian Griggs, M. Am. Soc. C. E., Chief Engineer of the Department of Public Improvements, had been very earnest in the advocacy of this course, believing it to be the only one that would be effective. Accordingly, in November, 1901, the work was commenced on the Front Street Viaduct, over the Little Miami Railroad, and 12,600 sq. ft. were cleaned and repainted, under the supervision of the writer as engineer in charge. When the weather became suitable for it, in April, 1902, the work was resumed and continued on this and the other viaducts named until the middle of November. The cleaning done amounted, in all, to 135,500 sq. ft. of surface. The cost and other data relative thereto are shown in Table No. 1. Four viaducts and the south span of the High Street Viaduct were completed. It is likely that the other three spans of the High Street Viaduct, and the Fourth Street Viaduct, will be cleaned and repainted during the coming season of 1903.

It was impracticable to secure good contract work at a reasonable price, and

all the sand-blast cleaning, as well as the painting, was done by men hired by the day. Two Newhouse sand-blast machines, mounted on light trucks, so that they could be moved about and placed where convenient for the work, were used in cleaning the viaducts named in Table No. 1. A wire-bound, 1½ in., rubber air-hose, 50 ft. in length, connected each machine with the 2-in. air pipe. Old rubber hose, which was much cheaper than new, was used for the sand hose, part of it being 2¼ and part 2½ ins. in diameter. The nozzles used were ½-in., extra heavy, gas pipe, of various lengths, from 12 to 24 ins. A length of at least 12 ins. seems to direct the blast with more effect than a shorter one. This was used instead of tool steel or other hard pipe because it was believed that it would last nearly as long and cost much less. The average length of time one nozzle lasted was about 5 hours, as shown by the length of pipe used and the total hours run. The nozzle was connected to the sand hose by a heavy, special cast reducer, about ¾ in. thick. This reducer was made thick, to sustain the wear caused by the deflection of the sand into the small nozzle pipe. The most severe wear of the nozzles is at a point 3 ins. from the connection with the reducer.

It will be noted that the sand, in passing from the large sand hose to the small nozzle, is deflected so as to produce a cross-fire, striking with greatest force against the sides of the small pipe near the reducer end. A like wear upon the rubber sand hose occurs near its connection with the pipe from the machine, which is a 1¼-in. pipe, and the spreading out of the sand to form the larger stream causes it to strike against the sides and then deflect to follow the direction of the hose. One foot in length, or sometimes a little more, cut from this end of the hose occasionally, fitted it for further use. The length of sand hose used varied from 25 to 65 ft., being regulated by the distance of the work from the place where the machine had to be placed. As the machines could not be placed upon scaffolding, in this work, at least 35 ft. of hose were required on nearly all the work, so as to reach from the ground to the floor system, from 16 to 20 ft. above the tracks, and in some places out over the tracks as far as 30 to 40 ft.

The nozzlemen should be men of some judgment and intelligence, so that they will understand how to manage the nozzle to make the blast most effective. When ready for work the nozzleman wore a helmet of tin, with cloth curtains hanging to the shoulders to keep out the dust, as far as possible. Instead of using wire gauze in the helmet, two pieces of glass were used for the nozzleman to see through, because it excluded the dust more effectually. When frosted over by rebounding sand, the glasses were removed and new ones inserted. After a little experience, a good nozzleman will learn how to hold the nozzle in any given case, varying its distance from the working point according to the manner in which he finds it is operating. Heavy scale requires him to hold the nozzle close, and light cleaning can be done more rapidly by holding it farther away and permitting the blast to spread somewhat and thus cut a wider swath. On moderately hard places about 5 to 6 ins. is the proper distance. To make it clean most rapidly he must also direct the blast so as to cut a swath clean as he goes, passing first in one direction and then in the other, across the member being cleaned, so as to leave no spots to which he must go back and thus waste the force of the blast on clean metal around them. The nozzle should generally be directed so as to strike the surface at a slight inclination from the normal, say 20 to 30° away from the nozzleman, thus blowing the dust and sand away. The cleaning should be carried forward from the nozzlemen, so that the blast will always act upon the exposed edge of scales, rust, or old paint, and, by getting under any loose portions, throw them off without first having to break them up.

The compressed air was supplied by the Union Depot Company, from a compressor with an air cylinder of 14 ins. diameter and a stroke of 12 ins., compressing the air to a gauge pressure of 50 to 60 lbs. The number of strokes was regulated automatically so as to keep the pressure nearly constant. The air was led from the compressor to a large receiver, and then, by a line of 2-in. steel pipe, to a small receiver at the viaduct where the work was to be done. From this receiver (having a capacity of about 9½ cu. ft.) the air was conducted to the sand-blast machines. The pressure at the machines was usually from 30 to 40

lbs. The requisite length of 2-in. pipe varied from about 1,250 to 2,200 ft. The small receiver had a pet-cock in the bottom to let out accumulated water, and it removed much of the moisture from the air used.

The compressed air was paid for by the city, at the rate of 40 and 45 cents per hour for one machine, and 60 cents per hour for two machines in operation. For 18 per cent. of the time only one machine was in operation. This made the work cost more, because two machines could have been operated for about one and one-half times what one would cost. A foreman, two nozzlemen and three laborers could operate two machines and dry the sand for them. The foreman was paid 35 cents, nozzlemen 25 cents, and laborers 15 cents during one-half of the time, and after that 17½ cents per hour.

The sand used was from Lake Erie. An attempt was made to secure rather coarse, clean and sharp sand; but it was at times impossible to do this without some delay, and some of the sand used was too fine and made much dust on account of the silt it contained. The sand was at first dried in two old locomotive ash pans, with old ties for fuel. This required almost constant attendance by one man, to stir it up and keep it from becoming so hot as to make the grains brittle and ineffective.

About May 1, 1902, the dryer was made by fitting a sheet-steel hopper on an old cast-iron stove. The wet sand would not fall through the ¾-in. holes in the lower part of the hopper, but would as soon as dry. The sand was permitted to cool for a few hours before being used, as hot sand caused steam and was likely to choke the small opening in the bottom of the hopper, around the end of the siphon nozzle. The objection to this kind of a dryer is that the fire-pot, being surrounded by sand in contact with it, burns out in a short time. Two fire pots were required in six months' service.

All the viaducts named in Table No. 1 have buckle-plate floor systems, exposing a large amount of steel surface to the action of rust and corrosion. It may be well to state the conditions under which the work of cleaning had to be done, in order to give a better understanding of the items making up the cost. The data here given may then be better analyzed and applied to any other proposed sand-blast cleaning. The first four viaducts named were erected during 1893 and 1894, and all were repainted during August and September, 1896, and none of them had been repainted since that time. High Street Viaduct was erected in the latter part of 1893, repainted in August, 1896, and again in October, 1899. The cleaning done before repainting, in each of these cases, was only hand-cleaning. All appearances indicate that the steel of the Front Street Viaduct over the Pittsburg, Cincinnati, Chicago & St. Louis and the Cleveland, Cincinnati, Chicago & St. Louis Railways, must have been in better condition than that of any of the other viaducts, and a better quality of paint must have been applied at the time of its erection. This is judged largely from the condition of the portions of the viaducts above the level of the street pavement and protected by it from the direct action of the blast and gases from the locomotives. The portion below the pavement, on all the others, are subjected to greater wear by the locomotive blast on account of their small clearance above the stacks, their clearance above the level of the railroad tracks being only 16.33 to 16.75 ft., while this viaduct has a clearance of 20.33 ft. In cleaning them, therefore, it was impossible to swing any staging below the clearance elevation, in the case of four of them. The Front Street and the Naghten Street Viaducts do not afford sufficient space above the lower surface of the plate girders in which a man can work, and it was necessary to work from movable trestles, about 12 ft. high, made as light as possible, so that they could be moved off the tracks whenever a train or an engine was about to pass, and be replaced and the work continued when the track was clear.

Under the first three viaducts mentioned in Table No. 1, there are two main tracks and one side track, with a spur track from the middle of the first, making four tracks under the east half of it.

Movable trestles were also used, part of the time, in cleaning the cover plates on the bottoms of the girders and the portion of the work along the abutments of the Maple Street Viaduct; but a large portion of the cleaning was done from staging resting upon the lower cover plates and angles of the plate girders.

TABLE No. 1.

Cost, etc., of Sand-Blast Cleaning of Viaducts at Columbus, Ohio.

Location of Viaduct.	Cost of labor.	Cost of flagmen.	Cost of compressed air.	Sand Used.		Dryer, sand blast, scaffolding, etc.	Total cost.	Number of square feet cleaned.	Cost per square foot.	Square feet cleaned with 1 cu. ft. of sand.	Square feet cleaned per hour by one sand-blast.	Average pressure at sand-blast, in pounds per square inch.
				Cubic yards.	Cost.							
Front St., over Little Miami Railroad	$385.30	$45.15	$139.40	54.00	$78.55	$56.68	$705.08	24 900	$0.0283	17.1	64	35
Naghten St., " " " "	140.74	17.85	56.40	28.44	42.41	32.52	289 92	8 000	0.0362	10.4	49	37
Maple " " " " "	223.00	11.90	94.80	34.50	58.08	58.70	446.48	17 000	0.0263	18.2	66	35
Front St., over Pittsburg, Cincinnati, Chicago & St. Louis and Cleveland, Cincinnati, Chicago & St. Louis Railways	670.66	....	229.80	92.65	107.43	87.18	1 095.07	63 000	0.0174	25.2	89	30
High St. (South Span)........................	951.20	....	319.94	129.91	161.47	122.46	1 555.07	22 600	0.0688	6.1	23	38
Totals and Averages	$2 370.90	$74.90	$840.34	339.50	$447.94	$357.54	$4 091.62	135 500	$0.0302	14.8	54	33
Excluding High St. Viaduct	....	....	....	....	....	....	2 536.55	112 900	0.0225	20.0	74	33

To secure the safety of the men while at work on these three viaducts, when using the trestles over the tracks, it was necessary to have flagmen to give warning of the approach of trains, so that the trestles could be removed in time to avoid the danger. On the Maple Street Viaduct flagmen were not needed for so large a proportion of the time as on the other two viaducts. The cost of flagmen alone amounts to about 0.2 cent per square foot on the first two in Table No. 1, and 0.07 cent on the Maple Street Viaduct. The time lost on account of trains and switch engines sometimes amounted to one-fourth of the working time. If there had been no interruption by trains, and if flagmen had not been required, a fair estimate, from approximate calculations, based on records of the time lost each day and the cost of flagmen would reduce the cost for the work to about the following figures: Front Street Viaduct, 2.3 cents; Naghten Street Viaduct, 3 cents, and Maple Street Viaduct, 2.45 cents, per square foot. Matched flooring screens, fastened with copper nails, were placed immediately over the main tracks and under the floors of these three viaducts, to protect them from the blast from locomotives.

In the Front Street Viaduct, over the Pittsburg, Cincinnati, Chicago & St. Louis and the Cleveland, Cincinnati, Chicago & St. Louis Railways, in which the clearance was 20.33 ft., the staging was supported on iron hangers which reached 2 ft. below the lower flanges of the floor beams. This space, with the 29 ins. more to the buckle-plates, gave room enough for the work, and the staging still gave about 2 ft. more clearance than the High Street Viaduct, just east of it and over the same tracks. The portion of the three heavy trusses above the pavement was in very fair condition, and it was not thought necessary to clean it with the sand-blast. This saved the cleaning of 36,000 sq. ft. of metal surface on this viaduct, while, on the others, practically all was cleaned. Some of the paint was still good, and it was not all taken off. This, together with the fact that there was not much interruption to the work, made the cost of cleaning, on this viaduct, less than on any other, all the others being much affected with rust, scale and corrosion upon nearly all parts of them, even above the level of the pavement, where protected from the direct action of the gases.

The south span of the High Street Viaduct, the portion already cleaned, is over the main freight and passenger tracks, and yard engines pass under it frequently. The other spans can be cleaned for very much less than this one. It has been estimated by men who are in the employ of the Pennsylvania Railway Company that an average of from 250 to 300 engines pass under this span every 24 hours. The girders and buckle-plates were in very bad condition, and very heavy and exceedingly firm scale had been formed over large portions of them. This scale was firmly cemented to the steel by the rust and carbonates which had formed. As a consequence, the sand-blast did not blow off much of it, nor did it work under the scale and throw it off, as on the other viaducts. Therefore, it cost nearly twice as much as the highest of the others, and nearly four times as much per square foot as the large Front Street Viaduct. The floor system is similar to that of the Maple Street Viaduct, the pavement being supported by seventeen plate girders. Immediately east of this is the structure under the roadway to the Union Station, also having seventeen plate girders. The distance over both is about 165 ft., and this, with the girders extending 3.5 ft. below the floor, causes the smoke to hang a long time between the girders after an engine has passed beneath. Often, it does not clear away before another engine comes along and again fills all the spaces with dense smoke. The smoke, and the dust from the sand-blast work, therefore, caused a great deal of trouble. It was very difficult, and part of the time impossible, to get nozzlemen to keep both blasts in operation. To get rid of the smoke and dust, an electric fan was tried for a short time, it being placed near the abutment between the girders where the work was progressing. This kept the smoke from rising, and cleared away the dust quite well; but the bearings were injured very much by the dust and fine sand. Then the blower was made. This was connected with the air pipe by a ½-in. rubber hose, and a jet of compressed air, passing through an opening of about 1-32 in., and into and through a section of 5-in. sheet-iron pipe, about 2 ft. long, set up a current of air, which, being directed along between the

girders, was quite effective. One of these was made for each sand-blast, and they were used for a considerable portion of the time. Smoke and dust, however, would gather behind the blower and be drawn through it at times, and it was not a complete success. It was effective for a distance of about 20 ft.

Another cause of the high cost of this work was the low pressure secured at the sand-blast machine during much of the time. The operation of the blowers tended to reduce it, and the compressor was worked beyond its intended capacity, and was not at the time doing as good work as earlier. The average pressure, at this viaduct, as stated in Table No. 1, is partly an estimate, as the gauge was broken and for a portion of the time was not in use. When at 30 lbs. or less, the sand-blast was very slow in cutting the scale here encountered; but when at 38 to 40 lbs., it was much more efficient. Occasionally, when only one blast was in operation for a short time, the pressure would run up to 45 lbs., and then the effect was still better.

From the experience in sand-blast cleaning here given it may be stated safely that, for heavy scale and corrosion, in situations such as this High Street Viaduct, a pressure of from 35 to 45 lbs. per square inch is not any too high. On the other hand, very efficient work is done at a pressure of about 25 lbs., where only light scale, rust spots and disintegrating paint are to be cleaned off. The labor costs approximately twice as much as the power, and increase of power is advisable where needed.

On all the cleaning done, the bright surface of the steel, having almost the appearance of frosted silver, was exposed to view by the removal of every vestige of rust, scale and old paint. The pitted portions, with a little more brushing, were as well covered with the paint as the others, and, after one year, it still holds on them as firmly, to all appearances, as when it first dried, after being put on.

The paint was applied very soon after the sand-blast, and sometimes curtains of heavy muslin were stretched between the painters and the sand-blast to prevent the dust and sand from interfering with the painting. All surfaces cleaned were painted before night, and rarely was it necessary for the painters to work more than half an hour after the sand-blast was discontinued for the day. It is best to work with the wind, so that it will carry the dust and sand away from the painters and nozzlemen.

Some records of actual results are shown in Table No. 2, both in the ordinary work of cleaning, and on tests in which an accurate account was taken for all the data presented therein. In some of these records there are omissions because all the elements were not noted. The long-time records give only the surface cleaned, and not the sand used or the horse-power necessary; and the two, showing results as to the whole work, are included for the sake of comparison. In these two are given some other results of calculations, from known quantities and records, which represent rates for one sand-blast, although two were running about 82 per cent. of the time. The number of hours stated is obtained by adding together the number of hours run by each machine. The tests of October 16th and 31st, 1902, were made in order to determine the relative effectiveness of nozzles of different diameters, from ¼ to ¾-in. in size. The sizes of pipe given are the nominal sizes of gas pipe, with "Ex. H." added where extra heavy gas pipe was used, which, of course, is smaller in interior diameter than standard gas pipe. The last one noted was with a nozzle, made from three ¼-in. gas pipes, one end of each being inserted in a 1¼ × 1-in. bushing, and babbitt metal poured in to secure them there. While only made for an experiment, this nozzle gave very good results, it having the highest rate of cleaning, in square feet per hour. It used considerable sand, about the same as the ¾-in. pipe, but cleaned nearly one-half more.

All these tests were made on the High Street Viaduct, where, for all of them, the corrosion was, as nearly as possible, of the same character. The rates of cleaning are low, because, on this viaduct, the scale was so hard. These tests of nozzles were made with a sand hose 65 ft. in length. All the nozzles for these eight tests were 12 ins. long. It will be seen from the results that the ½-in. extra heavy pipe, which is ¾ in. when worn out, is about the proper size for this kind of work.

Improvements can certainly be made in this apparatus. Some of the appliances were made as experiments, and are rather

TABLE No. 2.

DATA AS TO THE OPERATION OF THE SAND-BLAST, AND TESTS OF NOZZLES OF DIFFERENT DIAMETERS, AT COLUMBUS, OHIO.

DATE.	DURATION.		Nominal size of gas pipe nozzle.	AIR PRESSURE.		Cubic feet of free air per minute.	Horse power required.	Cubic feet of sand used.	Area cleaned, in square feet.	Square feet cleaned per cubic foot of sand.	RATES PER HOUR.		REMARKS.
	Hours.	Minutes.		At compressor.	At sand-blast.						Cubic feet of sand	Square feet cleaned.	
1899. Sept. 27	....	29	¼″	..	35	170	20.4	1.52	110	72.5	3.14	227.6	Pittsburg, Cincinnati, Chicago and St. Louis Railway work.
1901. Nov. 14	....	55	½″ Ex. H.	50	35	170	20.4	6.60	144	21.8	7.20	157.1	Plate girder, considerably rusted.
" 16	....	26	½″ Ex. H.	50	36	...	....	2.20	77	35.0	5.10	177.7	Plate girder, paint nearly destroyed.
" 14	4	45	½″ Ex. H.	50	35	170	20.4	....	375	....	....	79.0	Plate girder (includes lost time).
" 16	3	..	½″ Ex. H.	50	36	...	....	....	322	....	....	107.3	Plate girder, paint nearly destroyed (includes lost time).
" 18	7	50	½″ Ex. H.	50	36	...	....	....	655	....	...	83.6	Plate girder, paint nearly destroyed (includes lost time).
" 19	7	30	½″ Ex. H.	50	35	...	....	....	825	....	....	110.0	Plate girder, paint nearly destroyed (includes lost time).
" 20	7	30	½″ Ex. H.	40	25	...	....	....	1,227	....	....	164.0	About 10% of paint good and not removed (includes lost time).
Dec. 7	13	30	½″ Ex. H.	48	33	...	....	....	1,000	....	....	74.1	Floor system over railroad tracks (includes lost time).
Nov. 14th, 1901, to Aug. 13th, 1902	1 519	..	½″ Ex. H.	..	33	...	....	5,658.9	112,900	20.0	3.72	74.3	First four viaducts in Table No. 1.
1902. Aug. to Nov.	990	..	½″ Ex. H.	..	33	...	....	3,507.6	22,600	6.4	3.54	22.8	High Street Viaduct, see Table No. 1.
Oct. 16	....	18	½″ Ex. H.	55	37	156	18.7	1.40	11.80	8.4	4.67	39.33	High Street Viaduct, test run.
" 16	....	24	⅜″	55	37	140	16.8	1.31	6.65	5.1	3.28	16.63	High Street Viaduct, test run.
" 16	....	27½	¼″	55	39	108	13.0	1.20	2.42	2.0	2.62	5.28	High Street Viaduct, test run.
" 20	...	27	½″ Ex. H.	..	35	...	....	3.30	18.70	5.4	7.67	41.60	High Street Viaduct (another blast running).
" 31	...	7¼	¾″	55	40	200	24.0	1.10	4.25	3.9	9.10	35.20	High Street Viaduct, test run.
" 31	....	18	½″ Ex. H.	55	41	170	20.4	2.20	14.00	6.4	7.33	46.67	High Street Viaduct, test run.
" 31	....	9	⅜″	55	42	156	18.7	1.10	6.60	6.0	7.33	44.00	High Street Viaduct, test run.
" 31	....	24	¼″	55	43	130	15.6	1.00	4.75	4.7	2.50	11.88	High Street Viaduct, test run.
" 31	....	7	3¼″	55	41	176	21.1	1.10	6.60	5.4	9.43	51.40	High Street Viaduct, test run.

crude. One observation may be made which will occur to all, that more sand-blasts might be added with advantage, if sufficient power to run them were provided. The work at Columbus was limited to two machines, on account of the small capacity of the compressor. Perhaps a larger pipe to convey the air would have added to the pressure at the machines, and to the effectiveness of the sand-blast. For ordinary cleaning of bridges and other structures, not subjected to such hard treatment as viaducts situated where much exposed to the blast and gases from locomotives, it is safe to say that, with a more perfect equipment, sand-blast cleaning can be done at from 1¼ to 2 cents per square foot. The advantages anticipated for this kind of cleaning, especially where almost a necessity, because nothing else will do the work thoroughly, are to be gained by a careful inspection at intervals after it is done, and the repainting, with ordinary, good hand-cleaning, before the paint has been worn off so as to set up the vigorous rusting process which comes when air and moisture get to the metal. In such locations as the viaducts in Columbus it seems to be the only thing that will do the work. For future construction in similar locations let every engineer beware of the use of steel exposed to locomotive blasts, as these will wear out any paint. The life of those structures already in existence, and others which may be built in the future, should be extended as long as possible by the use of the best means that can be commanded.

Notes on the Design of Riveter Yokes.*

There are three principal methods of driving rivets—by hammering by hand and finishing with a set or "snap;" by hammering with a pneumatic hammer, a device having a rapidly moving piston, striking several hundred blows a minute on a suitable die, or snap, inserted in the end of the cylinder; this is a quite recent method, but for field work is rapidly superseding hand riveting. The large majority of rivets for structural, boiler and plate work, however, are driven by machines, which squeeze or upset the blank rivet end to form a head. Compression riveters are of several distinct types; the oldest form is the hydraulic riveter, consisting of a cylinder and piston or plunger, operated by high pressure, carrying a suitable die. The work to be riveted is placed between the jaws of the machine, the made head resting in a suitable die, attached rigidly to the jaw or stake of the machine. Other machines are of the same general type, differing in the means for applying the power and the kind of motor fluid, as, for instance, direct steam-driven or air-driven. Toggle joint devices, actuated by air, steam, electricity or belts. A late design uses an air cylinder, acting as a hydraulic intensifier, with provision to give a considerable travel at low pressure, followed by a short travel at high pressure.

In all of the compression riveters, of whatever type, the moving die is on one leg or jaw, and the pressure reaction is taken up by an opposed jaw. In general, the form resembles a letter U, the two legs being either in one piece or united by bolts.

This paper will discuss the design of a pneumatic toggle joint riveter, of 12-foot gap, made in one steel casting, of sufficient stiffness to drive rivets 1¾ inches in diameter.

The pressure required to close hot soft steel rivets has been determined quite accurately by Sellers & Co., of Philadelphia, by means of experiments with a hydraulic press, with pressure-recording attachment. These tests have been fully described in the technical press in the past.

The net working result is that to close ordinary soft steel rivets, at bright red heat, with a round or button head, a pressure of 150,000 pounds per square inch of rivet section is required. For large rivets used in boiler work it is customary to heat the rivets as hot as possible, without burning them, in order that the material shall flow easily and completely fill the rivet holes. Under these conditions less power is required to close them, and a pressure of 129,000 pounds per square inch, rivet section, has been found ample.

The pressure required to drive a 1¾-inch diameter rivet, with round heads, is, therefore, the area 2 and 4-10 square inch by 129,000 pounds, or 309,600—say, in round numbers, about 300,000 pounds.

With the type of toggle joint used, assuming a cylinder 18 inches diameter, 12-inch stroke, with air at 80 pounds pressure, we have a total cylinder pressure of

* Written by Chester B. Albree, for the "Proceedings of Engineers' Society of Western Pennsylvania, January, 1903.

20,320 pounds, or, in round numbers, 20,000 pounds.

In the force diagram of the toggle used (as per the diagram, Fig. 1) we note that the strain, when upper end of the side links have traveled 13-16 of the total distance, is about 15 times the cylinder pressure, or 300,000 pounds—the required amount.

Observing the corresponding travel of the ram, we see that it has traveled to within 1-16 inch of its total travel of 5 inches, or practically the whole distance, hence the rivet head is practically finished at this point. In toggle joints the final pressure becomes theoretically infinite and the plunger travel zero.

The actual pressure on the rivet, however, is measured by the stiffness of the yoke, which yields somewhat under the stress.

In designing the yoke we aim to get the required stiffness with the least weight, and assume that with yokes of well-annealed O. H. steel castings, we may safely use unit strains of 10,000 pounds tensile and 14,000 pounds compressive. Castings, pulling 60,000 to 65,000 pounds, with elastic limit of 30,000 to 35,000 pounds, are used. The gap being 12 feet, or 144 inches, the depth at back of yoke was taken as 1-3 of the gap, or 48 inches. This proportion can be varied by changing the proportions of cross section, but experience has shown this proportion to give economical results.

The section was made an irregular I-beam form, having a tension head much larger than the compression end. We assume a section that looks about right, and by the well-known principles of graphic statics, divide it in layers (see

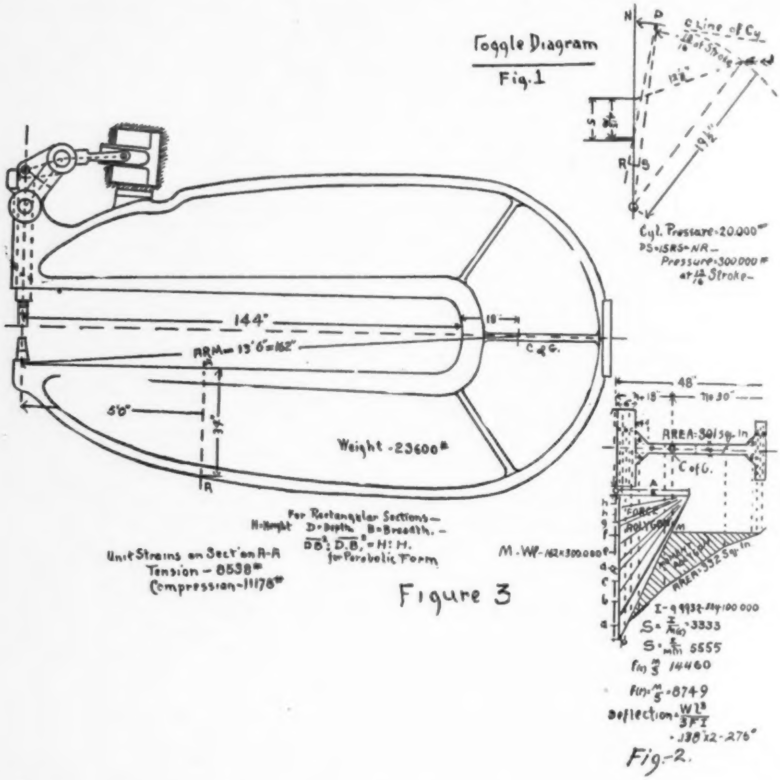


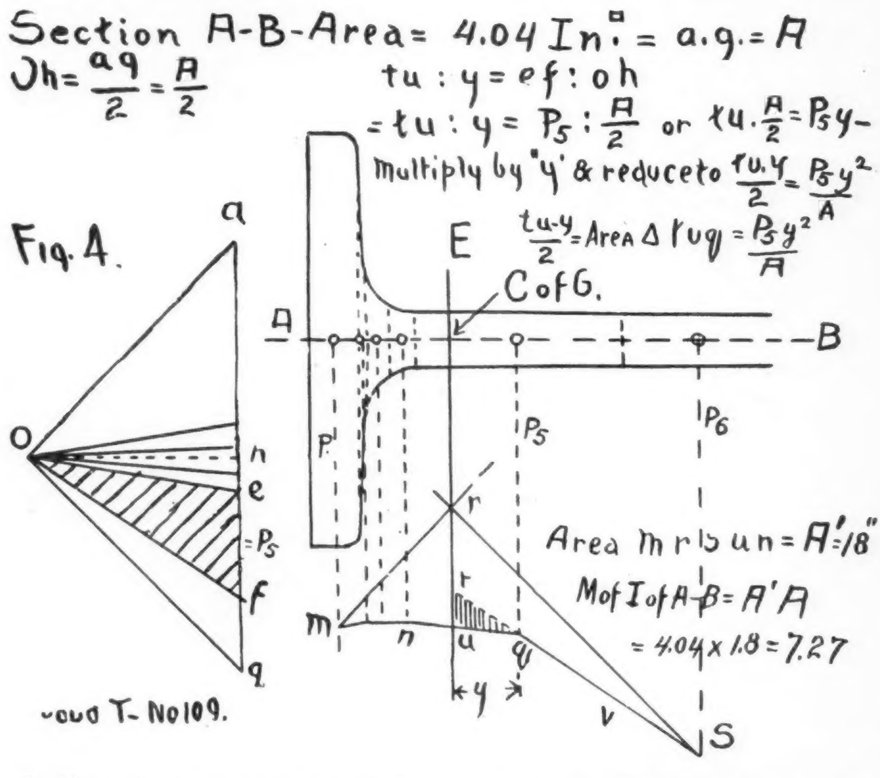
Figure 3

Fig. 2), determine area and center of gravity of each, and lay off the areas to some convenient scale and construct the force diagram, making the pole distance one-half the length of the load or area line.

This forms always a right-angled triangle, of which particular construction further mention will be made later. We then construct the equilibrium diagram, finding the resultant and locating the center of gravity of our section.

I have assumed that if the arm of the bending moment were taken as the diagonal from the end or nose of the jaw to center of gravity of the median section at the center of the curve, then the increase in length over the straight gap of the machine would compensate for the curvature and actual results in practice, as well as comparison with the mathematical solution, seem to justify the assumption.

Having determined approximately the length of the moment arm, we then have



In Fig. 3 is shown an outline of the yoke, which you will notice is curved where the two arms or jaws join. The exact mathematical determination of the strains in a curved beam of this shape are very complex. The problem has been studied by several mathematicians, including an exhaustive article published last year in the transactions of the Deutches Eisenhuttenleute Verein; but in practice our bending moment, which for a beam loaded at one end and fixed at the other, is simply Wl— or 300,000 x 162 inches.

Next determine the moment of inertia of the assumed cross section, which may be done analytically, arithmetically or graphically.

The graphic method is simplest, and we use a method shown in Molesworth's handbook, 1889 edition, which is simpler

than any other. Although most of you are probably familiar with it, yet for the benefit of those who have not used it I give the proof from Merriman and Jacoby's treatise on Bridges and Roofs—Part II, Graphic Statics, 1902 edition:

"We assume in Fig. 4 a standard T section, divide into convenient sections, letting areas be represented by force lines P^1 P^2—P^5.

Let oh be the altitude of triangle oag and y the altitude of triangle qtu; hence —tu :y=equals ef :oh—but ef=P^5 and oh=½A. or tu :y=P^5 :A-2. Multiplying this equation by y and reducing, we have ½tu.y=P^5 Y^2-A, but ½tu.y=area of triangle qtu.

If the area P^5 were of the width dy its moment of inertia would be P^5 Y^2. In like manner, the moments of inertia of

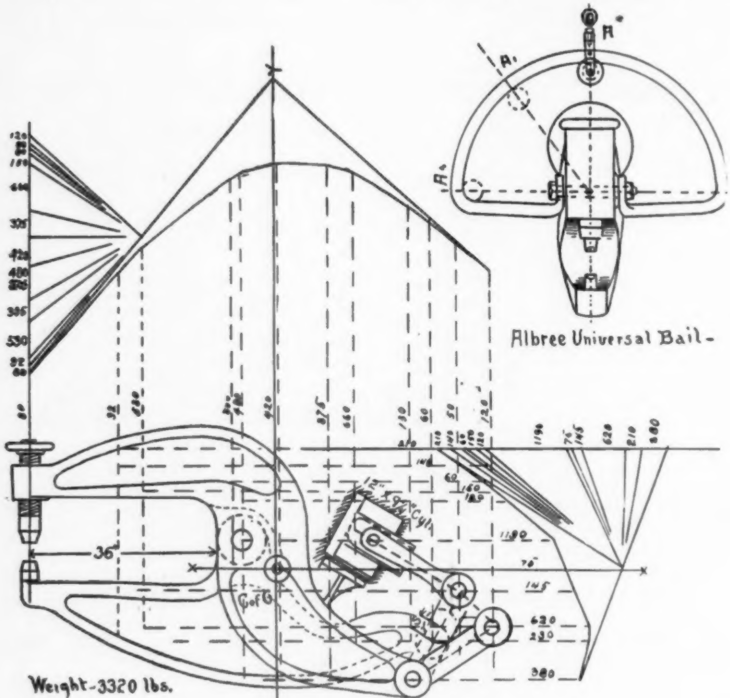


Fig. 5
36" Nipper Riveter—
For 1⅛" Rivets—

"Lay off the load line—ag—parallel to forces P^1—P^5 and proportional thereto, to some convenient scale; make the pole distance oh=½ ag=A2, and construct the force polygon—oag—which by construction is a right angle triangle.

Construct the equilibrium polygon m r s and determine the center of gravity of the Section A—B. Produce sq. to meet axis E at t—. Then triangles qtu and ofe are similar, as sides are parallel by construction.

each force P^1 P^2— — P^5 can be determined, and also the corresponding triangles and their sum, the moment of inertia of the whole section A—B would therefore be the total area of section multiplied by the area of the equilibrium polygon. This latter area, denoted by A_1, can be determined by a planimeter or otherwise, and we have—I=A^1A. Q. E. D.

Referring again to Fig. 2 and using the method just explained, we see the area of the section is 301 s. in. and of the moment

polygon, 332 sq. in., and their product about 100,000 as the M. of I.

In the well-known formula for the section modulus—$S=I/N$—and for extreme fibre strains—$f=M/S$—we find for tension 8,749 lbs. and compression 14,460 lbs., which are safe, and as a check, and to determine the deflection we use the formula

$$\frac{Wl^3}{3EI} = \text{deflection},$$

using E as 29,000,000, and find the deflection of the beam, supposing the section uniform throughout, to be .138 inches. As there are two arms, equally strained, the total deflection is .276, or a little over ¼ inch. In actual test the measured deflection was 7-16 inch, probably due to the tapering ends being designed a trifle light to keep outer stake small enough for certain work to be done. As this machine has been in constant use for over two years, and no permanent set has taken place, we feel assured of the results and methods.

Having fixed the median section, we design each arm to be a beam of uniform strength. Such beams may be various shapes, but the design chosen is a beam of I-beam section, in general similar to the median section, varying in size according to the parabolic curve, but having the inner edge on a straight line.

The exact proportion of depth, width, thickness of flanges and web might be figured exactly by a more expert mathematician than the writer, but the method adopted was to use the parabolic form for a rectangular cross section, and then finding the unit strains for different points and modifying the cross sections until these unit strains were practically the same as found for the median section.

In large castings blow holes or other defects sometimes occur, and often exist inside, but by omitting as far as possible cross webs and irregularities, fairly good castings can generally be obtained. In several hundred yokes that we have had, but two or three have failed under pressure, and then from blow holes at critical points.

This particular riveter is used for riveting marine boilers 10 to 16 feet diameter, having plates from 1 to 1¼ inches thick, and practically no rivets have had to be caulked to prevent leakage. For large diameter rivets it is best to allow the pressure to remain on the rivet until the steel is black, for if the pressure is taken off while rivet is still red hot the spring of the heavy plates will often stretch the rivet and a leak will be the result.

In small portable riveters it is often desirable to be able to use them in other than vertical planes, for crooked work. This has been generally accomplished by a double worm gear attachment forcibly holding the yoke in any desired position. The writer devised a special form of bail, called the universal bail, to accomplish this result in a simpler manner, permitting of more rapid adjustment.

In mechanics we read that a body will be in equilibrium if supported from above or below, from its center of gravity. Hence if a riveter were suspended from trunnions passing through the absolute center of gravity of the machine it would be in equilibrium, in a vertical plane, if the axis were parallel to the horizon. If the bail, instead of having the usual straight sides, is made in the form of a semi-circle, whose center is the center of gravity of the machine, then if the bail be suspended from any point of the arc, the machine would still be in equilibrium.

By suspending the bail on a trolley attached to a swivel above, the bail can be rolled around and the riveter worked at any angle in any plane.

To determine the exact center of gravity in advance of actually building a machine is necessary in order to locate the trunnion axis on the body of the machine in a convenient place and to provide bosses for trunnions on the pattern.

After designing the general layout of a machine, as in Fig. 5, bearing in mind the probable location of the center of gravity, we mark off on the plan various convenient parts whose weight can be determined, and ascertain as nearly as possible the center of gravity of each such portion. We then construct the force diagram and determine a line containing the center of gravity for one position. We then go through the same process, but for a position at right angles to the first, finding the center of gravity line for this position. The intersection of the two lines locates the absolute center of gravity, and as the machines are symmetrical as regards a median plane lengthways of the yoke, the determination in the third plane is unnecessary.

It is obvious that for machines having deep throats the center of gravity tends to come more nearly to a middle position

between the arms. As this location does not permit of placing the trunnions without interfering with the gap of the riveter, it is necessary to add weight to the upper side, at as great a distance from the jaw opening as possible in order to locate the trunnions on the body of the machine. In practice we find that for riveters over 48-inch gap, the extra weight and bulk are so great as to make such machines impracticable.

Compressed Air.*

Reference has been made to the use of compressed air and its facility of adaptation to various requirements; but it is evident, from an inspection of some of the devices in use, that enthusiasm for new methods, rather than good judgment, has prevailed in many of its applications. For some years compressed air was used only in mines, where it produced marked economies. Later, it was introduced into manufacturing lines, and to-day its use in railway and other machine shops, boiler shops, foundries, and bridge works is being widely extended.

The air is used to operate riveting machines, punches, staybolt breakers, staybolt cutters, rotary tapping and drilling machines, fine rollers, rotary grinders, rotary saws, pneumatic hammers, chisels, and caulking tools, flue welders, boring and valve-facing machines, rail saws, machines for revolving driving wheels for setting valves, pneumatic painting and whitewashing machines, dusters for car seats, and the operation of switching engines about the yard. It is also used in the foundry for pressing and ramming moulds and for cleaning castings by the sand blast; but its greatest field of usefulness is its application to hoisting and lifting operations in and about the works.

New applications of compressed air are constantly being made, and each new use suggests another. This has a tendency to increase the number of applications which are intended to be labor-saving devices, but in many cases the work could be done just as well and much more cheaply by hand.

A case in point is seen in an apparatus which was at one time in use on one of the more prominent railways. It was a sort of portable crane hoist which could be fastened to the smokestack of a locomotive whereby one man could lift off the steam chest casings. The hoisting apparatus weighed about twice as much as the steam chest and took three men to put it up. When piece-work was adopted two men easily lifted off the steam chest, and this "time and labor-saving device" was relegated to the scrap heap.

While compressed air has been used, to some extent, for inducing draught in forge fires, it is unquestionably a very expensive agent for such work. Tests have shown that it costs twenty-five times as much to produce blast in that way as it would with a fan.

The success and economy which have attended the use of compressed air in so many lines of work have led to its adoption in fields which are much better covered by electrically operated machines. While compressed air has been used very satisfactorily under certain conditions to operate pumps and engines, printing presses, individual motors for lathes, planers, slotters, dynamos and other work, it does not follow that it is always an economical agent for these various uses, or that other methods could not be used even more satisfactorily in the majority of cases.

It has been proposed to use individual air motors in machine shops and do away with all line shafting, except possibly for some of the heavier machinery. This use of compressed air seems entirely outside the pale of its legitimate field. General exnerience thus far indicates that rotary air motors are not at all economical, and generally are not as satisfactory as electric motors. Exceptions are to be found in the small portable motors for drilling and similar operations to which electricity is not well adapted. The saving obtained by the use of such portable air drills, as compared with a hand ratchet drill, is very marked.

Although these tools are very successful, they are still rotary motors, not exemnt from some of the objectionable features which seem to be inseparable from them. It is not surprising, therefore, to find a tendency to employ reciprocating pistons and cranks in these portable machines, and there are such tools weighing

*An abstract from Professor Flather's article on the "Modern Power Problem," written for *Cassier's Magazine*.

only forty pounds, capable of drilling up to 2½ inches diameter.

In most cases no attempt has been made to use the air efficiently; its great convenience and the economy produced by its displacement of hand labor have until recently been accepted as sufficient, and greater economies have not been sought.

In the matter of compression we still occasionally find very inefficient pumps in use, but manufacturers generally have learned that it pays to use high-grade, economical compressors. The greatest loss is that in the air motor itself. In a large number of cases it is impracticable, or, at most, inconvenient to employ reheaters, and we find very generally that the air is used at normal temperatures for the various purposes to which it is applied.

To obtain the most satisfactory results, the air must be used expansively; but usually where the demand for power is intermittent, no attempt has been made to reheat the air, and as a result the combined efficiency of compressor and motor is quite low, varying in general from 20 to 50 per cent.. While low working pressures are more efficient than high, the use of such pressures would demand larger and heavier motors and other apparatus which is undesirable. The advantages of higher pressures in reducing cost of transmission are also well recognized, and the present tendency is to use air at 100 to 150 pounds instead of the 60 or 70 pounds of a few years ago.

By reheating the air to a temperature of about 300 degrees F., which may often be accomplished at small expense, the efficiency is greatly increased; in some cases the increase has been found to be as high as 80 per cent. While the lower pressures are yet more efficient, the loss due to higher compression is not serious.

If air be used without expansion, there is a material loss in efficiency; but, on the other hand, if it be used expansively without reheating, trouble may be experienced from drop in temperature below the freezing point. With moisture present, this drop will cause the formation of ice, which may clog the passages if proper precautions are not taken to prevent it. The low temperature will not in itself cause trouble; if, therefore, the moisture which the compressed air holds in suspension be allowed to settle in a receiving tank, placed near the motor or other air apparatus, and frequently drained, trouble from this cause will be largely avoided.

While it may be impracticable to reheat the air in certain cases, yet there are many situations where a study of means to overcome the losses referred to would result in marked economies.

The greater adaptability of compressed air to various purposes causes its use to increase along with that of the electric motor, for it has a different field of usefulness, independent of power transmission; at the same time, when the requirements are properly observed in its production and use, its economy as a motive power in special cases compares favorably with that of other systems. With a better knowledge of the principles involved, we may expect much better results than have yet been attained.

New Cylinder Oil Atomizer.

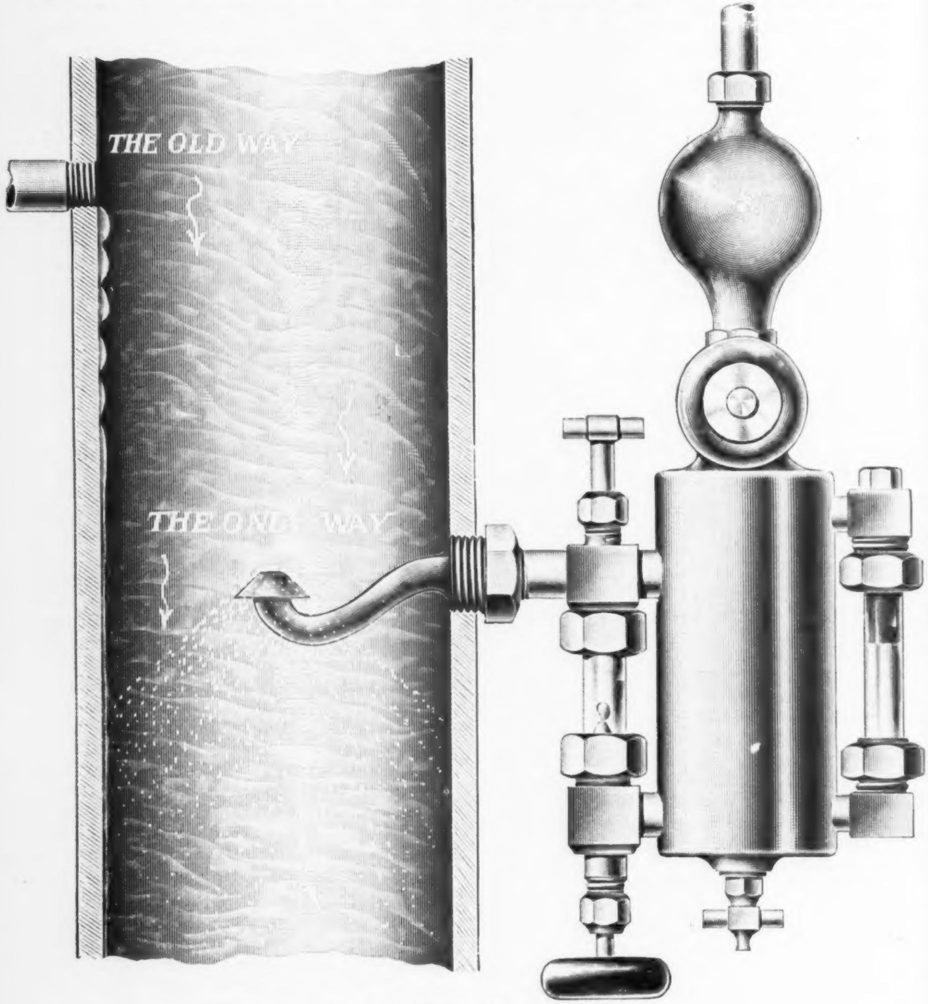
When cylinder oil is fed to a steam engine cylinder by means of the ordinary pump or sight feed lubricator, the outlets of which are merely tapped into the steam pipe, it is not carried by the current of steam to all parts of the cylinder and valves but tends to run along the inside of the pipe, working through gaskets and stuffing boxes and passing through the engine without being atomized and thereby oiling all rubbing parts of the cylinder, piston and valves. Of course by feeding a large quantity of oil the cylinder may be satisfactorily lubricated, but if it can be lubricated better with less than half the oil ordinarily used by atomizing it, so that the steam will carry it to all parts, then a saving of oil is accomplished, a perfect lubrication is maintained and less oil must be extracted from the exhaust in order to use the condensed steam again.

The device herewith illustrated delivers the oil in a thin sheet to the steam having the greatest velocity, thoroughly distributing the oil in a vapor through the steam and delivering same to all parts of the cylinder, oiling the upper part as well as the sides, and so effectually that one half the oil ordinarily used will, with this device, oil the cylinder better than the amount usually required.

This cylinder oil vaporizer consists of a bronze casting (see cut) so shaped that

the outlet is on a level with the inlet opening, one end of which is tapped into the steam pipe, as shown in cut. This end is tapped for lubricator or oil pump; and the action of the device is as follows:

limpid to spread out over the surface in a thin film, and as it reaches the lower edge of the cone is carried along with the steam. This cone is always small enough to go through the opening in steam pipe and all



NEW CYLINDER OIL ATOMIZER.

Oil flows in from the lubricator and, passing through the body of the vaporizer heated to the temperature of the steam and by the time it reaches the outlet at the top of cone is sufficiently thin and

the work necessary to put same on is to unscrew the lubricator connection, tap the pipe for atomizer screw into place, then screw the lubricator back into the atomizer.

The manufacturers of this device claim

that it is especially adapted for the heavy oils used with superheated steam, as the particles are thoroughly atomized and distributed where the lubrication is needed.

This atomizer is the invention of Mr. C. E. Sargent, Chicago, and is manufactured and for sale by the North Chicago Machine Co., North Chicago, Ill.

Railroad Car Braking.*

The advantage of the use of power, under the control of the engineer, for promptly applying brakes upon all the wheels of a train, early became recognized and the special advantages of compressed air for the transmission of the power throughout trains of considerable length, established the air-brake in a pre-eminent position. At first, the compressed air was stored in a reservoir upon the locomotive and, by means of a line of iron pipe, extending throughout the length of the train, with flexible hose and couplings between vehicles and an operating valve upon the locomotive, it was conducted to the brake-cylinder upon each car, by which the brakes were applied to the wheels, through the intervention of suitable rods and levers. The time required to convey the necessary volume of compressed air from the storage reservoir upon the locomotive to all the brake-cylinders of even a comparatively short train, and the total disability resulting from rupture at any point of the air-conduit, caused by this form of air-brake to be supplanted by the automatic air-brake, in which an auxiliary storage reservoir, of sufficient capacity to operate a single brake cylinder, was added upon each car. Through the operation of a triple-valve device, which connects the train-pipe or air-conduit, the auxiliary reservoir and the brake-cylinder upon each car, admission of compressed air into the train-pipe causes each auxiliary reservoir to become charged to operate the brakes, and discharge of air from the train-pipe, from any cause, causes communication with the auxiliary reservoir to be transferred from the train-pipe to the brake-cylinder, whereby a corresponding quantity of compressed air is discharged from the auxiliary reservoir into the brake-cylinder. By defining the reduction of pressure of air in the train-pipe, the pressure of the brake-shoes upon the wheels may be graduated to any desired degree within the limit established by the ultimate equalization of air-pressure in the auxiliary reservoir and the brake-cylinder, and accidental rupture of the tran-pipe instantly operates to stop the train and to prevent further progress without effective repair. In any case, restoration of the air-pressure in the train-pipe actuates the triple valve to re-establish access to the auxiliary reservoir, whereby it is recharged with air-pressure, and to transfer communication with the brake-cylinder from the auxiliary reservoir to the atmosphere, through which the brakes are released.

When the automatic air-brake became employed upon freight-trains, it was discovered that in making a quick stop by venting the train-pipe at the locomotive, the interval of time required to cause an operative reduction of the air-pressure in the train-pipe at the rear end of the train was so considerable that effective application of the brakes upon the rear cars was delayed until sufficient retardation of the forward portion of the train had become effected to cause collision with the rear cars that damaged and often disabled the cars and did violence to the lading. To remove this obstacle, the automatic air-brake, became superseded by the quick-action automatic air-brake, in which, when a quick stop is desired, each triple-valve opens a vent in the train-pipe, in addition to the vent upon the locomotive. By this means, an operative reduction of the air-pressure progresses throughout the train-pipe, of the longest trains, with nearly the velocity of sound, and damage from the serial character of the application of brakes by compressed air becomes practically eliminated. Incidentally, also, in the local venting of the train-pipe air at each succeeding triple-valve, the utilization of this source of power, formerly wasted at the engineer's operating valve, was accomplished by conducting the vented air into the adjacent empty brake-cylinder, before it receives the ordinary supply provided by the auxiliary reservoir. Thereby, the ultimate air-pressure in the brake-cylinder is augmented about 20 per cent., and the character of the application of the brakes in disaster-threatening emergencies is further distin-

*Abstracts from a paper read at the 171st meeting of the American Institute of Electrical Engineers, New York, Dec. 19, 1902.

guished from that in ordinary service, where neither the violence nor the power of the emergency application is desirable or even tolerable.

While the character of the development of the compressed air brake has thus been chiefly dictated by conditions rendered conspicuous by increased length of trains, and would hardly have been suggested under the conditions to which electric railroad operation appears best adapted, the high operative efficiency and other advantages thereby acquired are participated in by short as well as long trains, and are therefore of interest in dealing with the question of braking in electric service. Where even only two cars are operated together as a train, the automatic feature of the air-brake is still essential, in precisely the same way, if not in the same degree, as in longer trains, and, except where cars are always operated singly, the same is true of the increased efficiency secured through the quick-action feature of the automatic brake.

To enter into the detail of the air-brake apparatus employed to furnish the braking force, in a paper of this character, would unduly extend it and would also be a work of supererogation. The compressed-air supply generally implies a suitable compressor upon the car, or, if operated in trains, one or more upon each train. Storage of the compressed air in sufficient quantity has, however, been satisfactorily accomplished in some cases and possesses certain advantages. The air is usually stored at a comparatively high pressure (generally 150 pounds) in large reservoirs secured beneath the car, or in any other convenient place. It is delivered through a reducing valve into the "main reservoir" of brake operation, at the desired pressure, where it is handled in the ordinary manner. In such a system, a single air compressor, of large capacity and high efficiency, compresses the air at a station, where it is stored and charged into the car storage-reservoir from time to time. The advantages lie in avoiding the cost of installing and maintaining compressors upon all the cars, and in cheapness of operation. The disadvantages consist of the bulkiness of the storage-reservoirs and the time required to stop and charge them, and also the limited distance that may be transversed during the intervals. Where the air is compressed upon the car, the compressor must be accessibly constructed and placed upon the car, and supplied with clean, dry air. It may be operated by steam, by a separate electric motor, or by the car-motor, through suitable connection with the car-axle, as circumstances render it expedient. Its operation should be so controlled by a governor that it shall cease whenever the maximum storage-pressure has been attained in the main reservoir, and shall be renewed when operation of the brakes has reduced the storage-pressure to the inferior limit.

Upon the motorman's operating valve, the satisfactory operation of the brake-system in large measure depends. It must not only present the means of accurately gauging the force of brake-application and of promptly releasing the brakes, but must also define, with precision, the pressure of the air with which the auxiliary reservoirs are charged, to insure the full efficiency of braking without exceeding it to the injury of wheels and detriment of efficiency; while, at the same time, it must provide a superior pressure—that may vary considerably under different conditions—in the main storage reservoir, to insure prompt release of the brakes and restoration of pressure in the auxiliary reservoirs, without any variation of the working pressure in the latter—an exacting combination of conditions not easy of realization, but of capital importance.

Of the apparatus for the immediate application of the brakes to the wheels, sufficient has already been said, it having been indicated that, in the single case where the unit invariably consists of a single car, simply an air-cylinder, in communication with the motorman's valve, meets all the requirements, while the conditions of every other case justify nothing short of the efficiency of the quick-acting automatic apparatus, and, where characterized by high speeds and frequent stops, the superior efficiency of the high-speed brake is essential to high efficiency of service.

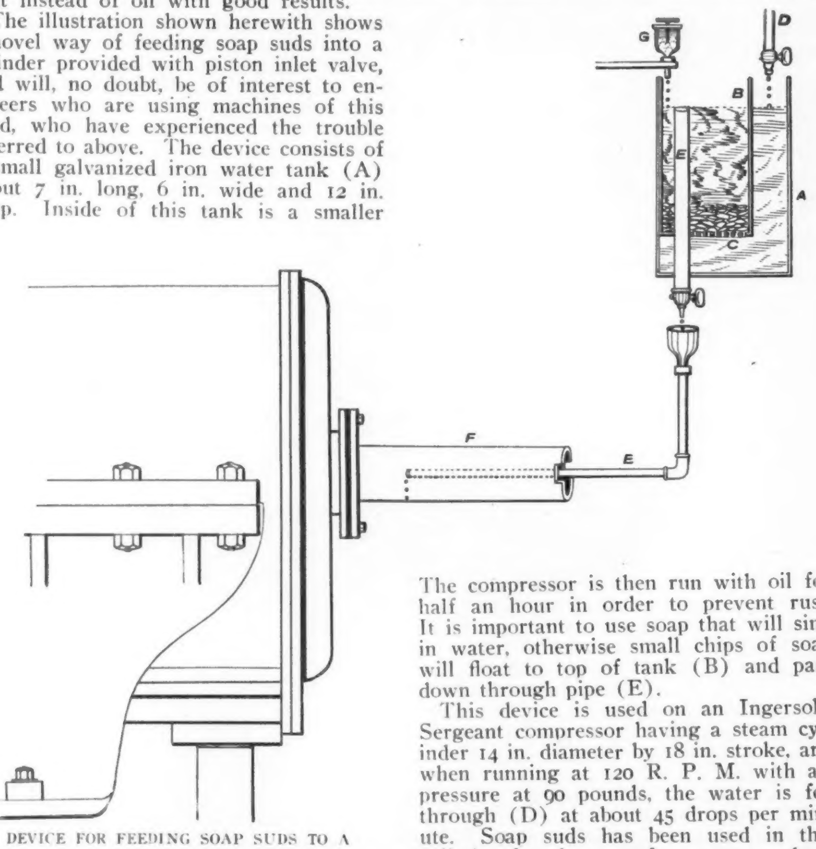
Lubricator for Feeding Soap Suds to Compressors.

In compressing air to 90 and 100 pounds gauge pressure with a single stage air compressor, the temperature of the air after compression frequently reaches 450° to 500° F. This high temperature results in more or less carbon being de-

posited on the discharge valves and passages, and trouble is often experienced in properly lubricating the air cylinder.

Especially is this the case where compressors are run at high speed and the temperature of intake air exceeds 80 degrees, or where an inferior grade of oil is used. To overcome this trouble, soap suds has frequently been used as a lubricant instead of oil with good results.

The illustration shown herewith shows a novel way of feeding soap suds into a cylinder provided with piston inlet valve, and will, no doubt, be of interest to engineers who are using machines of this kind, who have experienced the trouble referred to above. The device consists of a small galvanized iron water tank (A) about 7 in. long, 6 in. wide and 12 in. deep. Inside of this tank is a smaller one (B), which is soldered to the large tank, and the bottom of which is about 2 ins. above the bottom of large tank. In the bottom of small tank are a number of holes ⅛ in. in diameter, shown at (C). Soft brown soap (cut up in small pieces) is put into tank (B). Water is then fed into large tank through a ¼ in. pipe (D) and passes through small holes at (C), dissolves some of the soap and raises to top of ¼ in. pipe (E), through which it passes down into inlet of compressor. The water is regulated at (D), the small cock under tank being left wide open. Just before shutting down compressor the water is turned off at (D) and oil is fed into the small tank (B) from cup (G).



DEVICE FOR FEEDING SOAP SUDS TO A COMPRESSOR.

The compressor is then run with oil for half an hour in order to prevent rust. It is important to use soap that will sink in water, otherwise small chips of soap will float to top of tank (B) and pass down through pipe (E).

This device is used on an Ingersoll-Sergeant compressor having a steam cylinder 14 in. diameter by 18 in. stroke, and when running at 120 R. P. M. with air pressure at 90 pounds, the water is fed through (D) at about 45 drops per minute. Soap suds has been used in this cylinder for the past four years and no trouble whatever has been experienced in properly lubricating it. The engineer reports the walls of cylinder in perfect condition.

The arrangement shown has been used with much success at the power plant of the Terminal Railroad Association in St. Louis, and was made by the chief engineer at that plant, Mr. E. A. Kolbe.

Springfield Air Lift Plant, Elizabethtown Water Co., Springfield, N. J.

This plant covers about 107 acres, over which are scattered 53 driven wells, connected to a reservoir centrally placed and nearby the power house, where the boilers, pump and air compressors are located. These wells vary in size, some being 6 inches, others 8 inches and 10 inches in diameter, all being cased to rock at a depth of 100 to 150 feet. The total depth of the wells vary from 250 to 750 feet, all in rock, the rock portion being uncased.

The air lift system using a central tube is employed, the water pipes being 4 inches and 3 inches in diameter, and the interior air pipe 3/4 inch in diameter. The average depth of air pipe is 150 feet. To distribute the air to these different wells, 4 1/2 to 5 miles of wrought iron pipe is used, varying in diameter from 10 inches at the power station to 8 inches, 5 inches and finally 3 inches, the larger pipe being flanged coupled, the smaller pipes having screw couplings.

The system of collecting mains consisting of cast iron water pipe with caulked joints and leads from the most remote wells to the reservoir. These collection pipes vary from 4 inches all the way up to 30 inches in diameter, water being returned by gravity flow. The reservoir is "L" shaped, built of concrete and cement lined and has a total length of 150 feet, a depth of 15 feet and a width of 10 feet. One arm of the "L" shaped reservoir is extended out towards the well and the other is just back of the power house, arranged so that when additional machinery is installed the pump suction is kept the same.

The power house (Fig. 1) consists of two separate buildings, one being used for the boiler house, the other containing the pump and compressor. The pump is a Worthington Duplex, with triple expansion steam cylinders, having a 24-hour capacity of 6,000,000 gallons, taking steam at 80 lbs. and delivering water at 50 lbs.

The compressor (Figs. 2 and 3) is an Ingersoll-Sergeant compound steam, duplex air, Corliss semitangye type, of about 240 H. P., with steam cylinders 14 in. and 26 in. by 36 in. stroke and two air cylinders 20 1/4 in. x 36 in. stroke; rated speed, 78 R. P. M.

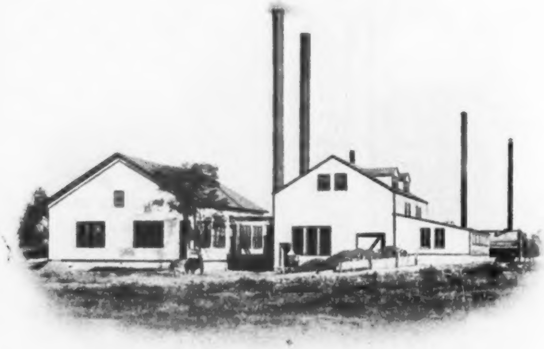


FIG. 1—POWER HOUSE SPRINGFIELD PLANT ELIZABETHTOWN WATER CO.

This compressor has a capacity of 1993 cubic feet free air per minute, the air being delivered through a 10-inch discharge pipe into a vertical receiver 54 inches diameter by 12 feet high, placed just outside of the building. The final maximum air pressure employed is 95 pounds, and the boiler house contains two Babcock & Wilcox boilers of 125 H. P., capable of carrying 110 lbs. steam, and two Hughes & Phillips 100 H. P. boilers, delivering steam at 80 pounds pressure.

We are indebted to the Elizabethtown Water Co. for the information above given.

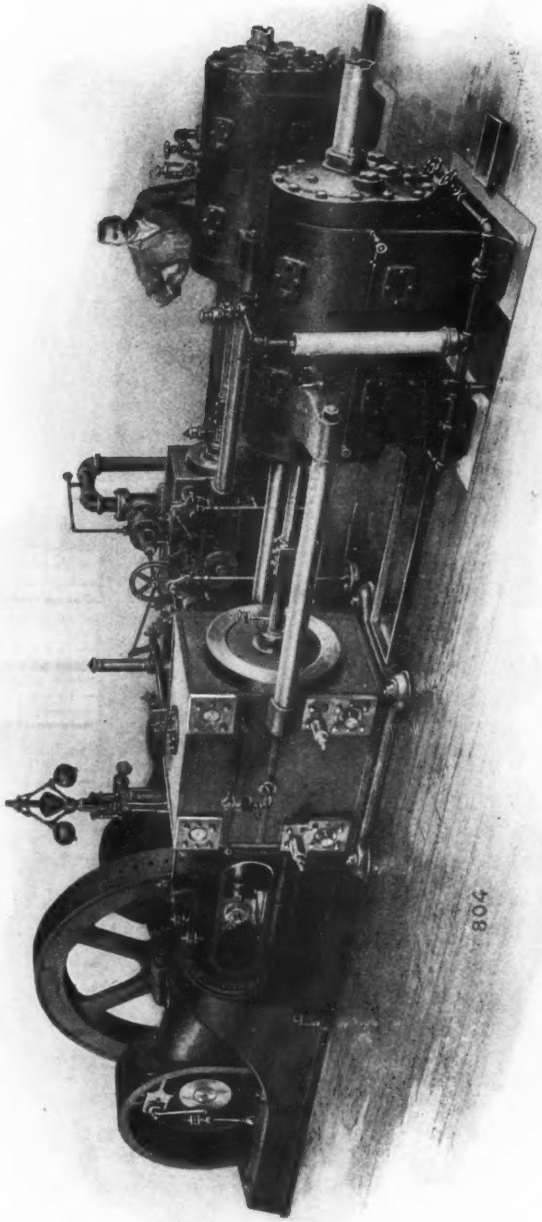


FIG. 2—INGERSOLL-SERGEANT COMPOUND CORLISS AIR COMPRESSOR, SPRINGFIELD, N. J.

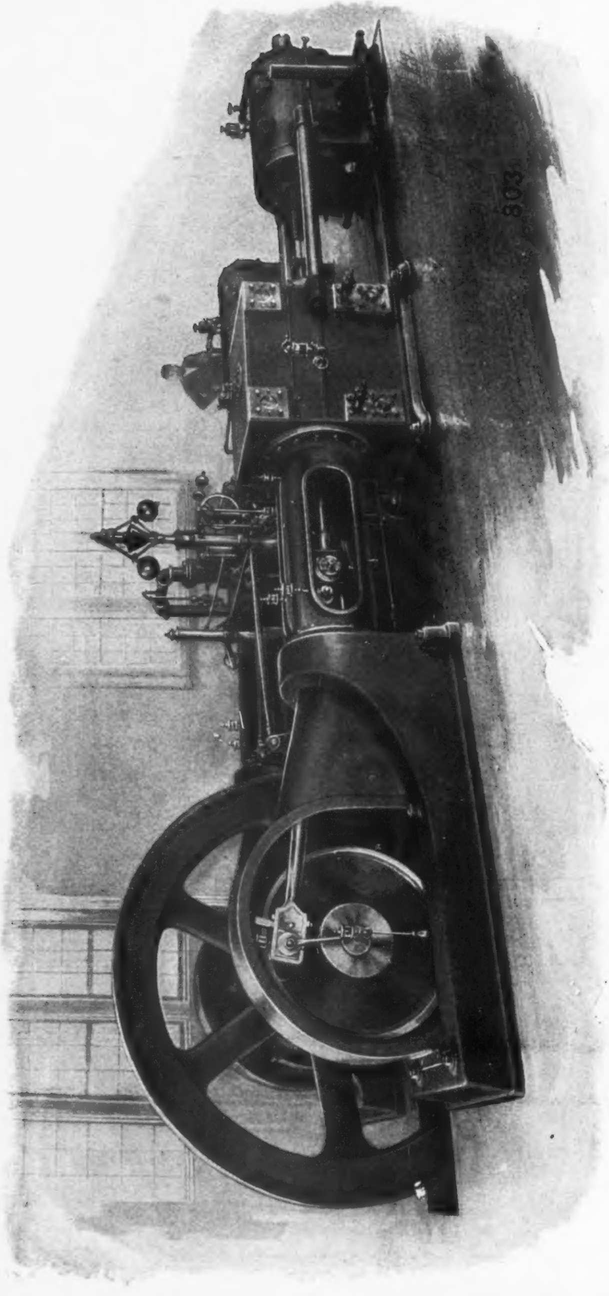
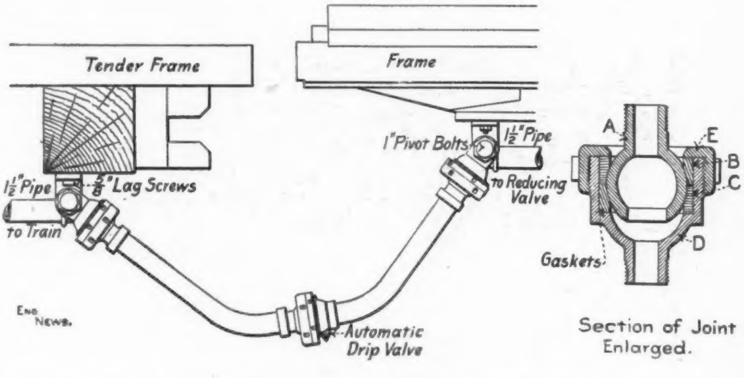


FIG. 3—INGERSOLL-SERGEANT CORLISS AIR COMPRESSOR. STEAM CYLINDERS, 14 x 26 x 36. TWO AIR CYLINDERS, 20¼ x 36.

A New Flexible Metallic Joint.

We illustrate herewith a new flexible metallic joint which is said to be steam, air, water and oil tight, and to ensure positively tight connection wherever movement or vibration occurs between the parts connected. The joint is the invention of Mr. J. C. Martin, Jr., Vice-President of the Holland Co., 77 Jackson Boulevard, Chicago, which company is handling the joint as one of its specialties.

The joint is of the ball and socket type, but does not depend upon internal pressure or the fit of ground surfaces for tightness, the metallic surfaces not being in contact. The end of one of the pipes to be connected is screwed to the bronze ball casting A, upon which are fitted two gaskets, B and C. These are of a special hard, non-metallic material, and their inner faces are moulded to fit the ball and form its seat. The gaskets fit within the head of the bronze socket D (which is attached to the other pipe to be connected), and when the joint is put together the gaskets are held in place by a flanged ring E, screwed upon the socket head. The wear is taken by the front gasket, as the pressure forces the ball forward. When this gasket becomes worn, the ball may be disconnected, the flange ring unscrewed, and the rear gasket put in the place of the forward one. The old front gasket or a new one may then be used for the rear gasket.



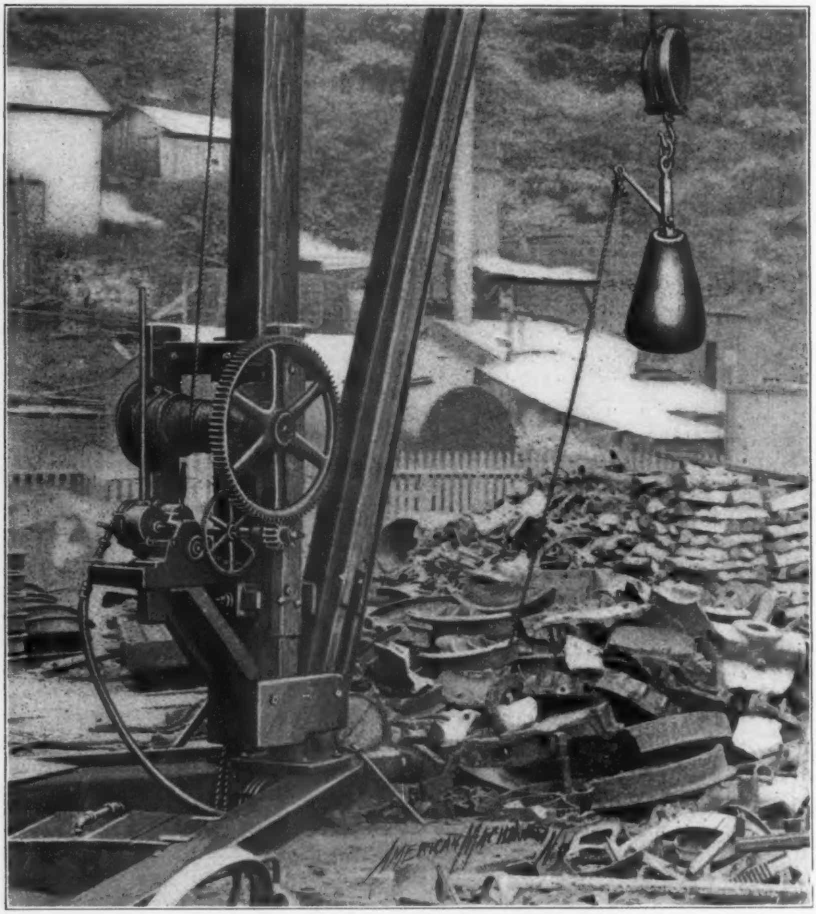
THE MARTIN FLEXIBLE METALLIC PIPE JOINT. THE HOLLAND CO., CHICAGO, MAKERS.

So far the joints have been used only for steam-pipe connections between engines and tenders, and they are in experimental use for this particular purpose on several western railways. The arrangement is shown in the accompanying cut. Three joints are used in the connection, the two end joints giving a bend to the pipe and being attached to the engine and tender frames by special malleable iron fittings, which give flexibility and prevent any strain from coming upon the pipe. At the center joint, the pipes are bent so as to give a straight passage, and in all the joints the diameter of the opening is greater than that of the pipe. They are steam tight under pressure, and are fitted with automatic drip valves to prevent the accumulation of any moisture in the joint. This drip is a flat composition seated valve, held up by a light spring of about 5 lbs. pressure.

The metallic connections are said to occupy no more space than the ordinary rubber hose connections, and to be as readily applied as the latter. Experiments are now being made for the purpose of applying this metal pipe and flexible joint between railway cars, with straight port couplers interchangeable with the present equipment. The metal pipe and flexible joint may also be adopted as a substitute for lengths of 25 to 50 ft. of hose, three or more joints being used to give the required freedom of movement.

An Air Driven Crane.

The accompanying photograph shows the application of an air motor to an ordinary foundry yard crane which had been operated by hand for years. This crane is used for unloading heavy scrap from cars and also for a "drop" or casting breaker. With this improvement two men will break more than twice as much scrap, and do it easier, than six men could operating the crane by hand. The motor is placed on a braced shelf made of 3½-inch plank. The gear on the motor spindle and the one into which it runs are a couple of odd change gears from an old lathe in the machine shop. The labor of applying the motor was an hour or so for the carpenter and five hours for a machinist, the gears and plank being the only extra material used.



CRANE WITH AIR MOTOR.

An incidental advantage of this arrangement is that scrap comes to the cupola

in smaller pieces, resulting in a better mix. "Winding" the weight up by hand was so laborious that men preferred any job around the foundry to that of breaking scrap, but with the motor attachment all the irksomeness of the job has been removed.—ANTHONY STAFFORD, in *American Machinist.*

Ventilation in Cornish Mines.

Supplementing the report of the special committee appointed by the South African Government to investigate the cause of miners' disease, an abstract of which was published on page 2193 in COMPRESSED AIR, we find the following in the London *Morning Post*:

"For some time Dr. J. S. Haldane, F. R. S., has been engaged, along with Mr. J. S. Martin, his Majesty's Inspector of Mines, in an inquiry undertaken at the instance of the Home Office as to the ventilation of Cornish mines. Of these the largest and most important is Dolcoath, and for some years the men working there have suffered from a disease to which the name "Dolcoath Anæmia" was given. They paled as to the face and the lips, and if they exerted themselves they suffered from palpitation. They were liable to become dizzy and faint and were suspected of having heart disease. Almost the whole of the patients from Dolcoath had an itching of the skin, with pustular eruptions which they called "bunches." Neglected cases became gravely complicated, and there was a danger of heart failure. Death might occur, the immediate cause being some intercurrent disease, such as pneumonia or phthisis. Dropsy might also supervene.

Most of the cases occurred in one particular shaft; indeed, everybody who worked there was affected in greater or less degree. Generally they were soon incapacitated from work underground, and it was found that they improved rapidly when they had been employed for a little while at the surface, where daily reinfection was impossible. In some instances this beneficial change was effected simply by shifting them to another shaft.

On investigation Dr. Haldane came to the conclusion that the men were suffering from ankylostomiasis. This is a disease which is caused by a worm that lives and multiplies in the upper part of the small intestine. This worm is about half an inch in length, and has a "suctorial" mouth with four teeth. In 1854 it was recognized as being the cause of a disease then common in Egypt and known as "Egyptian chlorosis." Soon afterwards it was found to be common in Brazil, and since then it has been recognized as a frequent and a troublesome cause of disease in tropical and sub-tropical countries all over the world. The disease has occurred on the Continent—it broke out among the workmen engaged in making the St. Gothard tunnel—but in England it has only been observed by Dr. Manson among Lascars at the docks.

Some three or four years ago it had occurred to the manager of Dolcoath that the disease might have some connection with a certain lack of cleanliness underground. He improved the ventilation, and he had large quantities of chloride of lime and permanganate of potash used in the infected parts of the mine. Dr. Haldane has no doubt that by taking this step he checked the progress of the disease. Cornish miners are constantly going abroad, but they frequently return after a short time, and sooner or later they go back to their old employment. Thus, it is supposed, Dolcoath was infected. The conditions were favorable; among other things the temperature was high. In one of the levels Dr. Haldane found it to be 79 deg. The disease, once it has been recognized, can be treated without difficulty, except in advanced cases, for the worms are expelled from the system immediately on the administration of thymol. At the time when this report was written one patient was so ill that it was not thought that he could recover. Dr. Haldane states in an interim report to the Home Office, which has just been published, that steps have been taken to disinfect the dangerous parts of the mine, and to make the conditions such that the worm, even if it should be reintroduced by some one coming from abroad, will find life impossible. The precautions are all in the direction of securing cleanliness and good ventilation."

South Tacoma Air Lift Plant.

The illustration on the following page represents a test well at South Tacoma, Wash., and affords an excellent idea of the discharge from an air lift well.

The test in question was made on January 21, 1903, the well flowing 800,000

gallons in twenty-four hours. Air for this was furnished by a 12¼x14 inch Class B compressor, manufactured by the Ingersoll-Sergeant Drill Co., and the well was piped according to the Pohlé Air Lift Systems, patents for which are controlled by the above company. The tests were made by L. Forrest McConihe, M. E., to whom we are indebted for the illustration.

the inner cylinder is of 20-inch pipe. The cylinder heads and piston are cast iron and the piston rod is a piece of 6-inch pipe. The inner cylinder and piston are packed with leather to prevent leakage of air while in operation. A check valve is to be attached to the air distributing pipe between the globe valve and drain cock to maintain pressure in the cylinder

SOUTH TACOMA AIR LIFT PLANT.

Telescoping Air Jack.

The air jack recently built by the Hicks Locomotive Works, Chicago Heights, works on the same principle as the hydraulic jack, but moves quicker. The *Iron and Machinery World* says:

"The jack consists practically of two cylinders, one operating within the other, and a piston traveling within the inner cylinder. The outer cylinder is a section of 24-inch wrought iron pipe and in case of accident to the hose after pressure has been applied. The piston travels 14 inches within the inner cylinder, the inner cylinder in turn traveling 12 inches within the outer cylinder, giving a total travel of 26 inches. Around the top of the outer cylinder is a steel band, held in position by tap bolts, supporting two journals which are designed to fit in bearings on a truck constructed to transport the jack to any desired point about the shop."

Book Review.

"Dies, Their Construction and Use for the Modern Working of Sheet Metals," by Joseph V. Woodworth, 505 illustrations, 384 pages, size 6x9 inches. Publishers: Norman W. Henley & Co., 132 Nassau street, New York City.

A treatise on the design, construction and use of dies, punches, tools, fixtures and devices, together with the manner in which they should be used in the power press, for the cheap and rapid production of sheet metal, parts and articles, comprising fundamental designs and practical points by which sheet metal parts may be produced at the minimum of cost to the maximum of output; with special reference to the hardening and tempering of press tools, the use of files, and to the classes of work which may be produced to the best advantage by the use of dies in the power press.

"Hardening, Tempering, Annealing and Forging of Steel." A Treatise on the Practical Treatment and Working of High and Low Grade Steel, by Joseph V. Woodworth; 201 illustrations, 288 pages, size 6x9 inches. Publisher: Norman W. Henley & Co., 132 Nassau street, New York.

This book comprises the selection and identification of steel, the most modern and approved heating, hardening, tempering, annealing and forging processes, the use of gas blast forges, heating machines and furnaces, the annealing and manufacturing of malleable iron, the treatment and use of self-hardening steel, with special reference to case hardening processes, the hardening and tempering of milling cutters and press tools, the use of machinery steel for cutting tools, forging and welding, high grade steel forgings in America, forging of hollow shafts, rock forgings, and grinding processes for tools and machine parts.

Notes.

At a meeting of the Compressed Air Company, H. Monkhouse was elected president, to succeed Henry Cooke, and Chauncey Truax vice-president, in place of Mr. Monkhouse. No financial statement was made.

Dornfield Pneumatic Malting Construction Company, Chicago, with a capital of $50,000; manufacturing machines and devices for brewing and malting, has been licensed recently, the incorporators being John F. Dornfield, Henry Ed Northcomb, Frank Little.

The Westler Young Compressed Air Pruning Co. has just been organized, with its principal place of business in San Francisco, Cal. Capital stock, $500,000, The directors are Westley Young, R. H. Hoilt, J. P. Harlon, T. A. Perkins, of San Francisco, and A. J. Newton, of Portland.

The steam turbine has lately been used in the reversed direction for compressing air, an ordinary steam turbine being coupled direct to the air turbine. This air turbine is very similar to the steam turbine, and consists, as usual, of alternate rows of moving blades and guide blades, and is driven at a high speed, each row of blades increasing the pressure, and giving a steady blast.

Elmer F. Woodbury, of the Hotel Cadillac, New York City, has outdistanced the builders of the new hotels that are being constructed on Broadway and Fifth avenue and inaugurated a new era in the hotel and restaurant business by the establishment of a pneumatic tube service between the dining room and kitchen. All of the new and modern hotels now in course of construction are making this great improvement.

A scheme is on foot for the purpose of connecting Montreal and Longueuil, Quebec, by means of a tunnel under the St. Lawrence. Plans have been submitted to the Department of Railways, providing for a double-track tunnel from the south shore to the heart of Montreal, where a central station will be placed. The structure, which will be of concrete and stone masonry, lined with enamel brick, will have a width of 27 ft. and a height of 21 ft.

William E. Nichols & Co. are receiving subscriptions to the $200,000 bond issue of the Compressed Air Company, $120,000 having been subscribed to date. These bonds are issued to liquidate the floating indebtedness, amounting to $47,000; improve the Rome Locomotive Works, the entire capital stock of which is owned by

the Compressed Air Company, and to further the development of the compressed air machines. A bonus of 100 per cent. stock is given with the subscriptions to the bonds.

The Great Central Railway Co., of England, in order to accelerate main line traffic, have just completed a contract with the British Pneumatic Railway Signalling Company for the installation of automatic pneumatic signalling through Woodhead Tunnel. Owing to the impossibility of manning a signal-box in so unfavorable an underground position, main line expresses are greatly impeded at this point. The underground installation, the first of its kind in Great Britain, will be, a northern contemporary says, a conclusive test of the trustworthiness of the electric track system under the most unfavorable atmospheric conditions.

Announcement has been made recently that the contract to construct a compressed air plant at the Cleveland Stone Co.'s No. 6 quarry, at North Amherst, O., has been let to the Ingersoll-Sergeant Drill Co. The building as planned is a structure 80x130 and the entire plant complete will cost $130,000. Engines and other machinery used in the compressing of air are now being constructed at the factories of the bidders in Cleveland and New York. The stone company intends to use this power in operating the drills, channellers, derricks and other machinery outside the big mill and they hope to have the plant in running order by August 1. The company claims this new power will be a great saving in time and will enable them to get out more stone and give employment to more men.

A correspondent writes *Modern Machinery*:

"In air valves commonly used on heating radiators of what substance is that portion composed which is so very sensitive to a change of temperature? What is its expansion per foot in variation of 100 deg. temperature?"

"The substance used in air valves," replied the editor, "which is supposed to be affected by changes of temperature, is common vulcanite, or hard rubber. It is known under the technical name of Ebonite."

"The expansion per foot is .000513246 of an inch for 1 deg. Fahr. For a variation in temperature of 100 degs. it would be 100x.000513246 or .0513246 in. per ft. of length."

In the lubrication of air compressors, where the air is sent underground, the use of vegetable oils, or any oils that will decompose easily, should be carefully avoided. For as the air is compressed, its temperature rises, causing a decomposition of all unstable oils, and the formation of carbon monoxide, which is a most deadly gas. This goes into the receiver with the air, and, escaping with the latter from the machines under ground, is liable to cause asphyxiation and death to the operators. A disaster of this kind recently occurred in a German iron mine. The usual supply of mineral oil had run out, and some rape seed oil was temporarily used. The pressure in the receiver was maintained at 80 pounds, and the temperature in parts of the compressor rose as high as 555° Fah. An analysis of the air escaping from the drills under these conditions showed that it contained nearly 6 per cent. of the deadly gas.

One of the great difficulties to overcome with gas engines of great power is the starting. In the case of the 400 H. P. Mono-Triplex gas engine invented by Mr. Letombe, it is remarkably easy and ingenious. The division of power greatly facilitates it, for up to 50 H. P. it can be effected by one man turning the fly-wheel. For greater powers, an automatic starting air reservoir is used. Compressed air from this reservoir is admitted behind the piston, and, driving it forward, causes it to make a compression stroke, followed by an explosion, the motor being thus started. When stopping, two out of the three combined engines are employed to work the third, in which the admission of gas has been stopped. The latter draws in and delivers air to the compressed air reservoir, where an arrangement of valves allows the air to be compressed to 7 or 8 atmospheres. The capacity of the reservoir suffices for three or four startings without requiring recharging.

The report of the directors of the Edwards Air Pump Syndicate (Ltd.) for the year 1902 states that during 1902 the royalties amounted to £4,792, as compared with £4,734 for 1901, while the ordinary ex-

penditure was £2,565, a slight decrease on the previous year. The number of pumps for electrical and other land installations shows a satisfactory increase, and for the first time has exceeded the number of marine pumps; the former representing 52 per cent., and the latter 48 per cent. of the total number of pumps booked. Additional pumps have been ordered by the British Admiralty and War Office, and the Edwards pump has now been adopted for five of the most modern battleships. It has also been fitted at Woolwich Arsenal (three sets). Chatham and Haulbowline Dockyards, and the Government Gunpowder Factory at Waltham. The foreign business of the syndicate is steadily expanding. The directors propose to apply to sinking fund account for redemption of cost of acquiring patents £1,000, and to pay a dividend of 6 per cent., leaving to be carried forward £165.

The beneficent results of keeping electrical or other particularly vulnerable machines clean are very generally realized, but the flexibility and efficacy of compressed air as a cleaner of such machines are not appreciated as universally as they might be, judging from the relatively limited number of such applications. One, and possibly the chief, advantage derivable from the use of compressed air to clean dynamos, motors, etc., is the ability to remove collections of foreign material without touching the parts of a machine on which they are lodged. By no other means is it possible to remove oil-soaked copper or carbon dust, for example, without either wiping or scraping the coated part. Perfect cleaning by wiping is almost impossible, to say nothing of the liability of making matters worse by the use of dirty waste or pieces of cloth; the serious objection to the scraping process is obvious. Another advantage of a compressed air cleaning system is that an outlet may be (and usually is) provided near each piece of machinery or apparatus, so that in many cases each one can be at least partially cleaned while in operation. In the worst cases, except those of enclosed machines, a shut-down of only very short duration is necessary for effecting complete cleaning.

No better evidence of the extraordinary growth of the Pennsylvania Railroad Company's business could be found than the fact that the big trainshed at Broad Street Station, Philadelphia, has become too small for the comfort of the thousands of persons using it every hour of the day and night. Radical improvements, including the extension of the trainshed proper and the enlarging of the space fronting the gates, are to be made at once in consequence.

Plans have been drawn by the engineering force of the company and actual work will be commenced in a few weeks. The train shed, already the largest in the world, will be extended something like 300 feet, bringing its western end to 17th street. As the trainshed begins only a few yards west of 15th street, the improved structure will be nearly two blocks in length.

The extension of the trainshed will make necessary a general reorganization of the pipes supplying compressed air to the trains. The whole system will have to be torn out and moved further west. The vaults for ice and the baggage lifts will also be moved. The signals guarding the tracks within the shed and governing the outer switches must also be changed. The work, it is said, cannot be done in less than a month's time, although big gangs of men will be busy night and day.

Results of tests by students at Cornell University upon the economy derived by re-heating air was recently published by the *Engineering and Mining Journal.* Gas was used as fuel for re-heating and was also metered, thus making very accurate testing possible. The motor was a two horse power vertical engine with a shaft governor, and was provided with a Prony brake and an indicator. The series of tests was made with several one-hour runs, gauge pressure varying from 57 to 82 pounds, and pressure of air raised by re-heating from 90 degrees to 320 degrees, the results being carefully recorded and tabulated. The following summary of the tests is from the *Engineering News.* For general purposes we need only give the following summary of results: (1) The net gain in economy was greatest for the lower gauge pressure of 57 pounds; (2) The curve of efficiency indicates that there would be no further gain by heating the air above 450 degrees F., and with the engine used 400 degrees F. was the maximum temperature consistent with smooth running, on account of the ill effects of a higher temperature upon packing and lubricant; (3) Re-heating the air relieves

the engine from difficulties due to freezing of the moisture in the exhaust passages, with resultant choking; (4) The economic advantages of re-heating were conclusively proved. A compressor able to supply 100 horse power of cold air to the motor, could supply 178 horse power by the use of re-heaters.

At a meeting of the North of England Institute of Mining and Mechanical Engineers, Mr. J. B. Atkinson (H.M. inspector of mines) said he had an opportunity before he left Scotland of seeing the first pit at Musselburgh, England, and was in the shaft two or three times during the sinking. It was no doubt a very sucessful operation, and the only difficulties they had were with regard to the brickwork and surrounding cylinder getting slightly out of plumb, and also when they had got so far down they neglected to add brickwork at the top, and the portion of it was caulked by wood lining and held while the rest of it went down; the difficulty, however, was overcome. In another case of sinking through alluvium, further to the north, near Larget, they had about 43 fathoms to go under the sea, and about half of this was alluvium. They first of all started the pit by forcing steel sheaths down the sides on end; that was not successful. They then tried cast iron, and that was not successful. Then steel cylinders were adopted, following much the same plan that was adopted at Olive Bank, but after they got so far down they would not move owing to boulders, and eventually they had to enclose the whole pit and use compressed air. They were two or three years getting through that twenty fathoms of alluvium. He thought in both these cases—certainly in the case near Larget—the freezing process would have been more successful. There was certainly less risk about it, but in connection with that method there did not seem to be sufficient details of costs given in the papers which had been read before the institute to enable them to judge which would be the best system to adopt. If the forcing down of cylinders was cheaper than the freezing process they might be inclined to take a certain amount of risk in using the cylinders, but if there was little difference in the cost, no doubt the freezing process would in almost all these cases be the best.

A very efficient method of watering the main roads is to conduct water under a considerable pressure through pipes laid along the side of the roads. These pipes may be from 1½ to 2 inches in diameter, and may be either fixed to timber set on the side of the roadway or laid along the floor with vertical branch pipes about ½-inch diameter fixed to it at intervals of every 25 yards, and about 3 or 4 feet in height. Suitable nozzles, jets, or sprays are fixed at the end of the vertical pipes, through which a thin spray of water issues into the air. A stop cock is attached to every pipe so that the water can be turned on and off at pleasure. The required pressure of water may be obtained from a pump column, or from an accumulation of water in an upper seam or on the surface. This method may be made more efficient by using compressed air in conjunction with water pressure. If this arrangement is used for this purpose alone it would, however, involve a considerable outlay for air-compressing machinery together with the main and branch pipes required for the purpose, but if the compressed air be used for doing other useful work so as to make the watering of the roads a secondary object, the water and air-pipe connections may be so arranged that the air and water can be brought together at the point of outlet.

The compressed air pipe may be laid along the main road parallel with the water pipe.

At each spray producer a small ½-inch branch pipe leads out from the main compressed air pipe parallel to the branch water pipe, and is connected to it by a nozzle in the interior of an ordinary T pipe, which forms the conjunction of air and water. Suitable valves are placed in the air and water pipes, which prevent the water from passing into the air pipes. When in action the water and air act simultaneously, and the water is spread in such a manner as to have the appearance of dew. In this way the air becomes throughly saturated, and the roof, floor, and sides of the roadways become damped. If this is done at suitable intervals the danger arising from accumulated dust will be obviated.

The transmission of power in mines constitutes, says Professor Courist, in a review of mine progress in 1902, compiled

for the Société des Ingenieurs Civils de France, the most remarkable part of the transformation that has been effected in mine working; and it is under the most various forms that energy has been transmitted and applied for supplementing the hard work of the miner. Compressed air especially has met with the most gratifying success. The results obtained in compressors tend by water cooling and injection, to effect an isothermic compression by the use of hydraulic pistons or by compensation, to lessen the influence of dead spaces; and lastly, thanks to the spring-loaded valves, to avoid the issue of compressed air on the inlet side with trepidation of the valves upon their seats. Compression in stages, chiefly recommendable for the storage of compressed air to be utilized in movable motors such as locomotives, or for producing the high pressures necessary to liquefy the gases in cold-producing machines for freezing water-bearing measures, has also been applied in mine working. The applications of electricity have become numerous for various purposes, such as working winches, haulage plants, fans and pumps. Electricity is, indeed, the most practical agent for transmitting power underground. Its conductors easily follow sinuous workings, while occupying less room than other methods of power transmission, and being more easily shifted from place to place. The useful effect of electricity is greatly superior to that of compressed air; and for the numerous appliances that only require rotary motion, the dynamo is the rotary motor "par excellence." Reserves must, however, still be made as to the use of electricity in working places impregnated with fire-damp, or that may become so; while dynamos, interrupters, and cut-outs should be enclosed in hermetically-sealed casings, and placed in situations where there is ample ventilation.

We note in one of the London papers the following:

In reference to the compressed air installation supplied to the Mysore (India) authorities in connection with the working of the Kolar goldfield, we are informed that the pressure used is mostly 45 lb., but all the 11 new compressors which are being installed in connection with the electric power plant are designed for 60 lb. pressure. The installation consists of:—Five 150 h. p. duplex air compressors, each cylinder 16¼ in. in diameter, 18 in. stroke, speed 110 revolutions, capacity to compress 910 cubic feet of air per minute to 60 lb. per square inch pressure. The driving pulley is 10 ft. in diameter, and grooved to receive nine ropes 1¼ in. diameter. The air receivers are 48 in. in diameter, and 12 ft. long. Four 200 h. p. duplex air compressors, each cylinder 18¼ in. in diameter, 24 in. stroke, speed 94 revolutions, capacity to compress 1,314 cubic feet of free air per minute to a pressure of 60 lb. per square inch. Driving pulley is 13 ft. diameter, and grooved to receive 12 ropes 1¼ in. in diameter. Air receiver 54 in. by 12 ft. long. One 300 h. p. duplex air compressor, each cylinder 22½ in. in diameter, 24 in. stroke, speed 94 revolutions. Capacity to compress 1,920 cubic feet of free air per minute to a pressure of 60 lb. per square inch. Driving pulley 13 ft. diameter, grooved to receive 12 ropes 1 1-12 in. diameter. Air receiver 54 in. by 12 ft. long. One 400 h. p. duplex air compressor, each cylinder 25¼ in. diameter, 30 in. stroke, speed 80 revolutions per minute, at which speed the capacity is 2,600 cubic feet of free air per minute at a pressure of 60 lb. per square inch. Driving pulley is 16 ft. in diameter, and grooved for 16 ropes 1½ in. diameter. All compressors have piston inlet air cylinders, with water jacket all round the walls and through all heads, and are provided with automatic sight feed lubricators for air cylinder jackets, automatic air pressure regulators, piping, and all other necessary details which form part of a complete installation. All compressors hitherto used on the field have been steam driven, carrying a small fly-wheel to equalize the angular velocity. In the case of the new compressors, these are driven by a large pulley through the elastic medium of ropes, which have proved so eminently successful in many large motor-driven installations. The compressors and air-tanks are manufactured by the Ingersoll-Sergeant Drill Company, of Queen Victoria street, London, this company being subcontractors for this section of the work to the General Electric Company of New York.

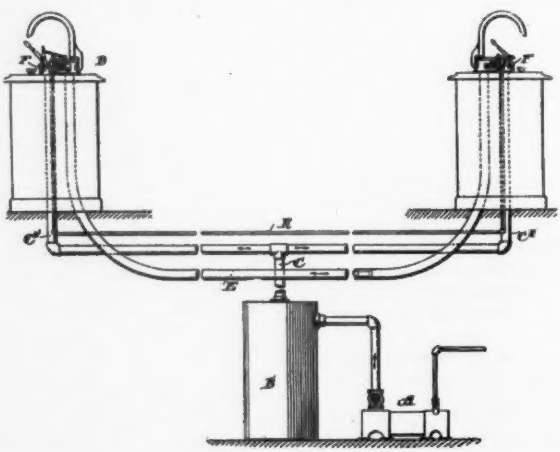
INDEX.

U. S. PATENTS GRANTED FEB. 1903.

Specially prepared for COMPRESSED AIR.

719,421. PNEUMATIC - DESPATCH - TUBE APPARATUS. Birney C. Batcheller, Philadelphia, Pa. Filed June 14, 1900. Serial No. 20,220.

valve-actuating mechanism whereby the closing of each gate opens the valve admitting compressed air to the closed end of the tube and the opening of the gate causes said valve to close, a latch arranged at each end of the tube to hold the gate closed and gate-retracting mechanism tending to open it, a pneumatic

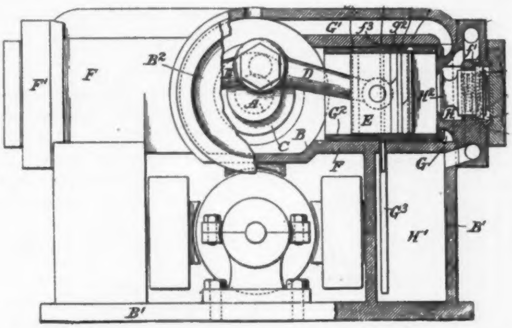


A pneumatic-despatch-tube system, a despatch-tube connecting two stations in combination with a compressed-air conduit or conduits connected to each end of said tube, a normally closed valve in the connection between each tube end and the compressed-air conduit, a gate for closing each end of the tube at will, unlatching device at each end of the tube, a pneumatic conduit leading from each station to the unlatching device in the other station, a connection in each station between said pneumatic conduit and the compressed-air conduit, a valve normally closing said connection and means actuated by a carrier arriving at

said station for opening said valve and thereby unlatching the gate and shutting off the air-supply in the other station.

719,454. COMPRESSOR. William J. Francke, New Brunswick, N. J., assignor to the Brunswick Refrigerating Company, New Brunswick, N. J., a Corporation of New Jersey. Filed Nov. 23, 1901. Serial No. 83,379.

719,451



A compressor, the combination with a cylinder, a piston, a suction-valve, and a discharge-valve, of a chamber forming an oil-cushion behind the suction valve, a chamber in front of the piston, a cônduit to deliver oil from the chamber in front of the piston to the first-named chamber, and a conduit to receive the oil escaping from the first-named chamber, prevent its escape behind the piston and return it to the second-named chamber through the discharge-valve, whereby the oil in the first-named chamber is under the discharge pressure.

719,70?. AIR-PUMP. Charles L. Wilkins, Columbus, Ohio, assignor to the Ohio Pump & Brass Company, Columbus, Ohio, a Corporation of Ohio. Filed Feb. 17, 1902. Serial No. 94,429.

An air-pump, the combination with the casing having a water-inlet, an exhaust-outlet below said water-inlet and a passage leading through the upper end of said casing and connecting with the latter by a port, a hollow plunger within the casing having an enlarged lower end portion, cup-leathers carried on opposite ends of said plunger, the lower end of the plunger having passages adapted to communicate with the interior of the plunger and an outlet-port formed in said plunger, of the tubular valve working within the plunger, and cup-leathers on opposite ends of said valve, of an air-cylinder surmounting said casing and having an outlet-opening in its upper portion, a weighted piston in said air-cylinder having a central under side socket, a rod extending through the upper side of said casing into said piston-socket and within said casing and valve and projections carried on said rod.

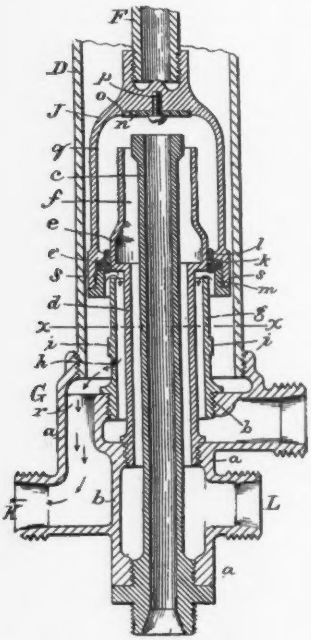
720,083. PNEUMATIC RENOVATOR. John S. Thurman, St. Louis, Mo. Filed Feb. 24, 1902. Serial No. 95,364.

The combination with the casing of a pneumatic renovator, of a handle therefor, a connection between said handle and said casing whereby the latter is movable with respect to the handle, and a duct or passage formed through the handle for compressed air entering said casing through the pivoted connection of the handle.

720,395. TERMINAL FOR PNEUMATIC-DESPATCH SYSTEMS. Hugo Ash and August Woltman, Chicago, Ill., assignors to National Pneumatic Service Company, Chicago, Ill., a Corporation of Illinois. Filed Mar. 17, 1902. Serial No. 98,459.

A device of the class described, the combination with a pneumatic-despatch tube, of a coupling attached thereto, a tube, connected to said coupling, said tube being oval in cross-section, and curved in a reverse curve, so that the end thereof farthest removed from said tube shall be substantially parallel thereto and nearer thereto than the main sweep of the curve formed by said tube, an exhaust-tube, suitably connected to said tube, a valve closing the bottom of said tube, and a consecutive-delivery hopper and chute below said valve and in line with the lower portion of said tube.

720,022. ANTIFREEZING COMPRESSION-VALVE. Philip Haas, Dayton, Ohio. Filed Aug. 5, 1901. Serial No. 70,933.



A device of the character described, the combination with means for receiving water from the source of supply; of a bell-shaped valve constructed to form a chamber or reservoir for receiving and retaining air and water; a supply-valve carried by said bell-shaped valve; an annular tubular stem communicating with the flush pipe and hopper or bowl when said supply-valve is closed, said stem being normally open to the outer air; and mechanism actuated by the closet-seat for moving said supply-valve to a closed position until the air and water in said valve-chamber have passed into the flush-pipe and flushed the bowl.

720,325. COMBINED STREET-CAR AND AIR-BRAKE COUPLING. Lewis. C. Cary, St. Louis, Mo., assignor of one-half to Julia Caldwell, El Paso, Tex. Filed Nov. 24, 1902. Serial No. 132,702.

A combination street-car and air-brake coupler, comprising a flaring half-bell-shaped guide portion; a head within which is formed a bifurcated air-passage; a circular neck opposite said half-bell-shaped guide portion; and a yielding locking-arm pivotally attached to the said head and adapted to lock the same to an opposing head.

720,376. SAFETY BRAKE APPARATUS FOR MOTOR-CARS. Charles F. Peel, Jr., New York, N. Y. Filed Sept. 11, 1902. Serial No. 122,912.

An air-brake-operating apparatus, a vertically-movable spring-operated rod, and air-valve connected with the lower end of said rod, said air-valve being in operative connection with the brakes, said rod being provided with a handle and foot-bracket and said spring-operated rod operating to open said air-valve and set the brakes.

720,486. PNEUMATIC STRAW-STACKER. William C. Robby and William M. Rumely, Laporte, Ind., assignors, by direct and mesne assignments, to the Indiana Manufacturing Company, Indianapolis, Ind., a Corporation of West Virginia. Filed June 21, 1902. Serial No. 112,610.

The combination in pneumatic straw-stacking apparatus, of a straw-collecting chamber having a tipping adjustable lower portion, a fan drawing its air with the straw from said chamber and located under said lower portion and tipping therewith, and a stacker-tube projecting from the fan-casing.

720,639. PNEUMATIC TIRE. Francesco Toni, London, England. Filed Sept. 8, 1902. Serial No. 122,580.

720,697. PNEUMATIC STACKER. Claus P. Jensen, Clarks Grove, Minn. Filed July 10, 1902. Serial No. 115,058.

The combination with a separator involving the straw-delivery rake and screens of the primary blower made up of the case and fan, and the secondary blower made up of the case and fan, said case being opened at its inner side and provided with the hood receiving from said rake, and said case having the hood receiving from said screens, the said two fan-cases being set vertically in approximately the same plane and having straw-delivery stacks or tubes delivering to different places exterior of the machine.

720,786. HOLDER-ON FOR PNEUMATIC TOOLS. Herbert S. Covey, Chicago, Ill., assignor to the Cleveland Pneumatic Tool Company, Cleveland, Ohio, a Corporation of Ohio. Filed Dec. 13, 1902. Serial No. 135-075.

A holder-on for percussion-tools, consisting of a split ring formed with inturned lips or flanges upon its edges and having two finger-pieces crossing each other from the split portions of the ring, whereby the ring may be spread and opened by pressing together upon the finger-pieces.

720-804. PNEUMATIC - DESPATCH - TUBE SYSTEM. Henry J. Hert, Indianapolis, Ind., assignor of part of his right to Thomas Bemis, Indianapolis, Ind., and Major Collins, Brazil, Ind. Filed Aug. 18, 1902. Serial No. 120,105.

A junction for pneumatic-despatch-tube systems, the combination with a pair of converging carrier-channels, of a stop-arm normally but yieldingly projected into one channel, a finger carried by said arm, a second stop-arm adapted to be projected into the other channel, and a finger carried by the second stop-arm and engaging the finger of the first stop-arm, for the purpose set forth.

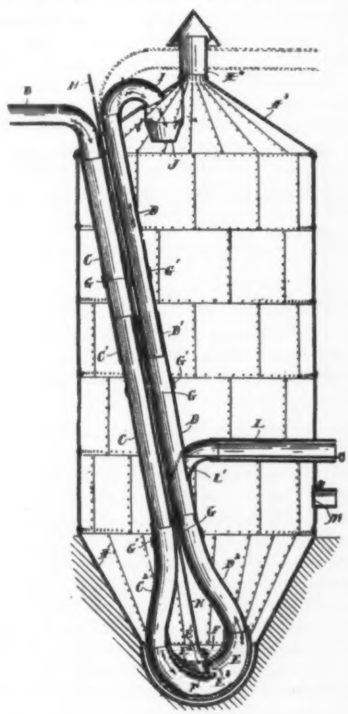
720,865. PNEUMATIC MASSAGE APPARATUS. Robert Watson, Washington, D. C., assignor of one-half to Charles A. Kram, Washington, D. C. Filed May 26, 1902. Serial No. 108,967.

An apparatus for the local treatment of disease by air pressure or vacuum, comprising a laterally-inclosed air-chamber having an opening adapted to be closed by the part of the body to be treated, and having an air-port, a reciprocative plunger for compressing or rarefying the air within the chamber and means connected with said parts for automatically opening and then closing said port during the stroke of the plunger.

720,872. GAS-COMPRESSOR. Stephen E. Alley, Glasgow, Scotland. Filed Nov. 18, 1902. Serial No. 131,872.

A "stage" gas-compressor the combination of a differential trunk reciprocating piston, a cylinder containing it and divided by the piston into two compression-chambers, a crank-shaft operatively connected with that piston, an inlet-valve chest, an outlet-valve chest, both chests extending along one side of the cylinder, an intercooler comprising a series of connected gas-tight pipes, an inlet-conduit from a source of gas-supply to the inlet-valve chest and thence to one of the two said compression-chambers, an outlet-conduit from that chamber to the outlet-valve chest and thence to the intercooler, an inlet-conduit from the intercooler to the inlet-valve chest and thence to the other of said compression-chambers, an outlet-conduit from that other chamber to the outlet-valve chest, two piston sliding valves one in the inlet-valve chest and in the inlet-conduits of that chest and constituting a gas-tight partition between them, and the other in the outlet-valve chest and in the outlet-conduits of that chest and constituting a gas-tight partition between them, and two eccentrics on the crank-shaft one operatively connected to the inlet-valve and the other to the outlet-valve.

721,145. PNEUMATIC CONVEYOR. James R. Burgess, Port Huron, Mich. Filed Oct. 13, 1902. Serial No. 127,072.



In a conveyor, an air-tube having straight parallel portions and a return-bend connecting said portions, said bend being provided with a throat and mouth in its concave side, vertical ways in the throat, a gate movable in said ways to close the mouth, and a rod to operate said gate secured thereto.

In a conveyor, the combination with a storage-tank for grain, of an air-tube extending downward within said tank to the bottom thereof and provided with a return-bend and extended upward through the top of the tank, said return-bend being provided with an opening or mouth, and a semicircular-shaped pipe detachably secured at one end to the end of the air-tube which extends upward through the top of the tank and having its opposite end projecting through the top of the tank to discharge the grain back into said tank.

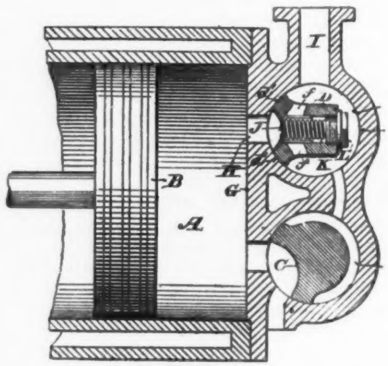
720,997. ART OF ESTABLISHING SUBAQUEOUS FOUNDATIONS. Edmund Becker, Washington, D. C. Filed Oct. 7, 1902. Serial No. 126,272.

A subaqueous foundation comprising an extended base and bulkheads projecting downwardly from the periphery and from intermediate parts of the said base to form separate air-chambers open below and adapted to be operated independently on the plenum system and other vertical but open partitions in each of said chambers to equalize the air-pressure in each chamber and serving with the intermediate bulkheads to prevent the contained water from rushing bodily about within the structure.

721,243. PNEUMATIC STACKER. Joseph K. Sharpe, Jr., Indianapolis, Ind., assignor to the Indiana Manufacturing Company, Indianapolis, Ind., a Corporation of West Virginia. Filed June 13, 1902. Serial No. 111,449.

The combination, with a threshing-machine, of a pneumatic stacker, comprising a straw-chamber, one end whereof is fitted to the upper portion of the rear end of the threshing machine and covers the straw-delivery opening therein, and the other end of which is reduced to the size of the next section of the straw-delivery trunk or duct, and the sides whereof converge from one end to the other, a delivery trunk or duct connected to the smaller end, two fans, suitable housings therefor, and air-ducts leading tangentially from the peripheries of said housings to the lower and outer sides of the straw-chamber and adapted to discharge the air along the sides of said chamber whereby the straw is subjected to the action of the air currents at the sides of the mass, and friction between said straw and the straw-chamber walls thus minimized.

721,221. DISCHARGE-VALVE FOR COMPRESSORS. Bruno V. Nordberg, Milwaukee, Wis., assignor to Nordberg Manufacturing Company, Milwaukee, Wis., a Corporation of Wisconsin. Filed Mar. 8, 1899. Serial No. 708,236.



A pump or compressor the combination with a cylindrical valve-chamber communicating with the pump-chamber through the discharge-port thereof and having an outlet-port, of an oscillatory discharge-valve having cylindrical bearings at the ends fitted in said chamber, and a longitudinal working face spanning the cylinder exhaust-port when the valve is closed, said valve being cut away outside of its working face between its end bearings so as to leave a space between it and the inner wall of the valve-chamber, and formed with passages leading through its working face into said space, and outwardly-opening spring-closed relief-valve seated in said passages, substantially as and for the purposes set forth.

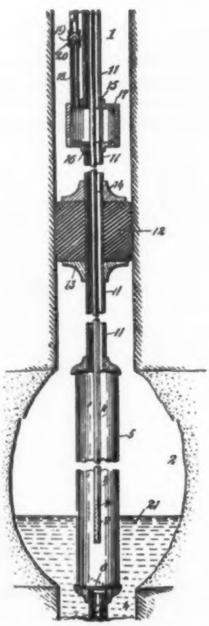
721,324. DIAPHRAGM FOR PUMPS, AIR-BRAKES, COMPRESSORS, OR THE LIKE. Edwin B. Rayner, Piqua, Ohio, assignor of one-half to William H. Rayner, Springfield, Ohio. Filed May 2, 1902. Serial No. 105,-699.

In combination with the distensible diaphragm of a pump, compressor or the like, a reinforcement applied to and covering a side thereof and consisting of a series of sector-shaped plates, substantially as set forth.

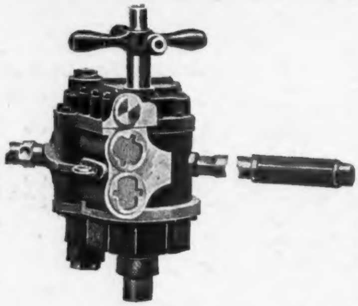
721,417. BLAST-FURNACE. Rudolf Berg, Pittsburg, Pa., assignor of one-half to Ferdinand Wenig, Pittsburg, Pa. Filed Oct. 2, 1902. Serial No. 125,613.

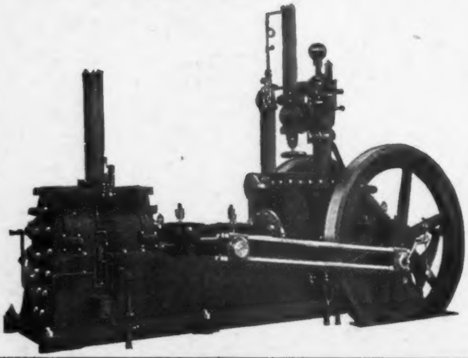
A blast-furnace, the combination with the boshes and twyers of the same, of means for supplying compressed and cooled air to the boshes and twyers, and through the same to the interior of the blast-furnace.

721,594. DEVICE FOR RAISING LIQUIDS FROM WELLS. Thomas F. Moran, De Young, Pa., assignor of one-half to Fred. J. Moser, Kane, Pa. Filed July 5, 1902. Serial No. 114,508.



A device for raising liquids from wells, comprising a pipe for conducting said liquids, a casing connected with said pipe and provided with inducts for admitting said liquids, a packing for preventing the escape of gases around said pipe, means for forcing air into said pipe, and for connecting said pipe with a reservoir for storing a quantity of liquid, thereby virtually increasing the capacity of said pipe.





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